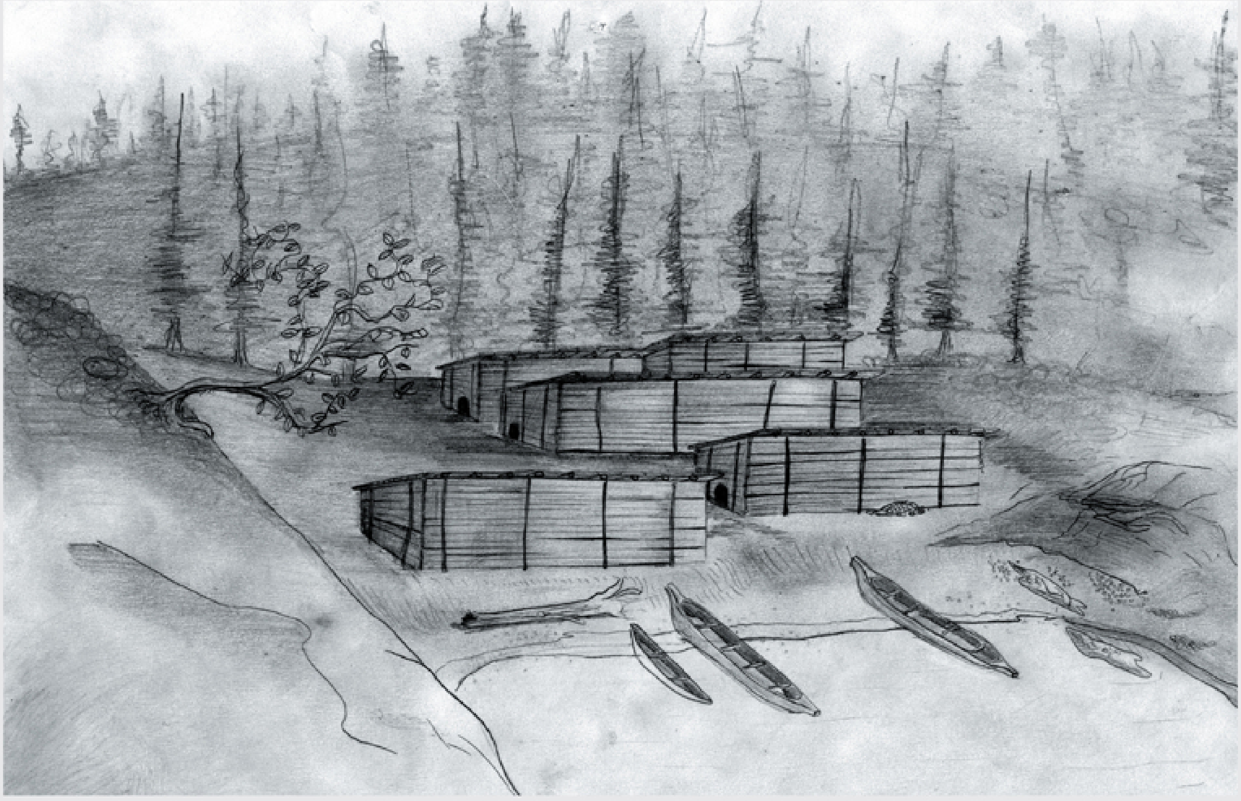
Proceedings of the 9th ICAZ Conference, Durham 2002

Beyond Affluent Foragers

Rethinking Hunter-Gatherer Complexity

**Edited by Colin Grier, Jangsuk Kim
and Junzo Uchiyama**



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Proceedings of the 9th Conference of the International Council of Archaeozoology, Durham, August 2002

Series Editors: Peter Rowley-Conwy, Umberto Albarella and Keith Dobney

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Oxbow Books

Published by
Oxbow Books, Park End Place, Oxford OX1 1HN

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ISBN-13 978 1 842 17125 7
ISBN-10 1 84217 125 9

A CIP record for this book is available from The British Library

This book is available direct from
Oxbow Books, Park End Place, Oxford OX1 1HN
(Phone: 01865–241249; Fax: 01865–794449)

and

The David Brown Book Company
PO Box 511, Oakville, CT 06779, USA
(Phone: 860–945–9329; Fax: 860–945–9468)

and

via our website
www.oxbowbooks.com

Printed in Great Britain at
Antony Rowe, Chippenham

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Preface

Peter Rowley-Conwy, Umberto Albarella and Keith Dobney

This book is one of several volumes that form the published proceedings of the 9th meeting of the International Council of Archaeozoology (ICAZ), which was held in Durham (UK) 23rd-28th August 2002. ICAZ was founded in the early 1970s and has ever since acted as the main international organisation for the study of animal remains from archaeological sites. The main international conferences are held every four years, and the Durham meeting – the largest ever – follows those in Hungary, the Netherlands, Poland, England (London), France, USA, Germany and Canada. The next meeting will be held in Mexico in 2006. The Durham conference – which was attended by about 500 delegates from 46 countries – was organised in 23 thematic sessions, which attracted, in addition to zooarchaeologists, scholars from related disciplines such as palaeoanthropology, archaeobotany, bone chemistry, genetics, mainstream archaeology, etc.

The publication structure reflects that of the conference, each volume dealing with a different topic, be it methodological, ecological, palaeoeconomic, sociological, historical or anthropological (or a combination of these). This organisation by theme rather than by chronology or region was chosen for two main reasons. The first is that we wanted to take the opportunity presented by such a large gathering of researchers from across the world to encourage international communication, and we thought that this could more easily be achieved through themes with world-wide relevance. The second is that we thought by tackling broad questions zooarchaeologists would be more inclined to take a holistic approach and integrate their information with other sources of evidence. This also had the potential of attracting other specialists who shared an interest in that particular topic. We believe that our choice turned out to be correct for the conference, and helped substantially towards its success. For the publication there is the added benefit of having a series of volumes that will be of interest far beyond the restricted circle of specialists on faunal remains. Readers from many different backgrounds, ranging from history to zoology, will certainly be interested in many of the fourteen volumes that will be published.

Due to the large number of sessions it would have been impractical to publish each as a separate volume, so some that had a common theme have been combined. Far from losing their main thematic focus, these volumes have the potential to attract a particularly wide and diverse readership. Because of these combinations (and because two other sessions will be published outside this series) it was therefore possible to reduce the original 24 sessions to 14 volumes. Publication of such a series is a remarkable undertaking, and we are very grateful to David Brown and Oxbow Books for agreeing to produce the volumes.

We would also like to take this opportunity to thank the University of Durham and the ICAZ Executive Committee for their support during the preparation of the conference, and all session organisers – now book editors – for all their hard work. Some of the conference administrative costs were covered by a generous grant provided by the British Academy. Further financial help came from the following sources: English Heritage, Rijksdienst voor het Oudheidkundig Bodemonderzoek (ROB), County Durham Development Office, University College Durham, Palaeoecology Research Services, Northern Archaeological Associates, Archaeological Services University of Durham (ASUD), and NYS Corporate Travel. Finally we are extremely grateful for the continued support of the Wellcome Trust and Arts and Humanities Research Board (AHRB) who, through their provision of Research Fellowships for Keith Dobney and Umberto Albarella, enabled us to undertake such a challenge.

Archaeozoology has played a major part in the study of hunter-gatherer variability since archaeologists began studying such variability. This is partly because the topic is a relative newcomer on the scene. Until the end of the 1970s most or all hunter-gatherers were thought to conform to the nomadic model so well presented in the landmark publication *Man the Hunter* (Lee and DeVore 1968), and before 1968 hunter-gatherer settlement patterns and society were rarely addressed at all by archaeologists. Archaeozoology was thus already a major component of archaeological work by the time hunter-gatherer variability became an important issue. It is also partly due to the fact that settlement seasonality is sometimes accessible using archaeozoological methods – indeed, bones may often be the only way to approach seasonality. Since season of occupation is crucial for our understanding of hunter-gatherer settlement patterns and society, there was an important role for bones from the start.

In more recent years the study has developed in a variety of directions, and many of these are celebrated in this volume. Early interest in hunter-gatherers who did *not* conform to the *Man the Hunter* nomadic model originated largely in the coastal areas of the northern Pacific Ocean. It was particularly gratifying that Junzo Uchiyama, a former student of Durham University, returned to Durham to organise a session on the issue at the ICAZ conference jointly with Jangsuk Kim. Japan and Korea have been key areas for our understanding of such hunter-gatherers, and the two session organisers are joined for this volume's editorial purposes by Colin Grier from the North American side of the Pacific. The introduction, by Uchiyama and Shuzo Koyama, one of Japan's most pre-eminent prehistorians, notes another landmark publication, the *Affluent Foragers* volume published in 1981, edited by Koyama and David Hurst Thomas (Koyama and Thomas 1981). This volume was instrumental in stressing hunter-gatherer variability beyond the *Man the Hunter* model. Most of its coverage was of the northern Pacific region. The present volume extends the coverage much more widely, both theoretically and geographically, building on *Affluent Foragers* to consider many instances with a degree of depth and detail scarcely possible just a few years ago. As Kim and Grier note in the concluding chapter, this makes it ever more difficult to generalise about hunter-gatherers. This volume reorients the focus from categorisation to the study of variability for its own sake – *Beyond Affluent Foragers* indeed.

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1. Why "Beyond Affluent Foragers"?: Looking Back at the Original Affluent Foragers Concept

Shuzo Koyama and Junzo Uchiyama

The Origins of the "Affluent Foragers" Concept

This aim of this volume is to reconsider the "Affluent Foragers" concept as it has been applied to so-called "complex" and typically coastal-adapted fisher-hunter societies. What follows in terms of case studies and discussion stems from the session "Beyond Affluent Foragers: The Development of Fisher-Hunter Societies in Temperate Regions" that took place at the 9th International Conference of Archaeozoology in Durham, UK in the summer of 2002. The session was organized by Junzo Uchiyama and Jangsuk Kim, with Shuzo Koyama acting as keynote speaker and Colin Grier chairing the post-presentation discussion.

Over twenty years ago, "Affluent Foragers" was coined as a shorthand term for the specific socioeconomic conditions of coastal fisher-hunters in productive environments. A central implication of this label was that during the Holocene certain prehistoric groups were recognized as having achieved highly organised social structures and high degrees of sedentism in the course of adapting to temperate coastal environments. The first symposium taking up "Affluent Foragers" as its subject matter was held in 1979, and was the third in a series of symposia funded by the Taniguchi Foundation at the newly opened National Museum of Ethnology in Osaka, Japan. The proceedings of the 1979 symposium were edited by Koyama and D. H. Thomas and published in 1981.

The primary goal of the 1979 symposium was to compare the foraging economies of prehistoric Japan and California. These two areas are both warm and economically productive temperate climate regions of the northern hemisphere. In contrast to hunter-gatherer societies that existed in harsh environments (at least for the outside observer) such as the high arctic tundra and Australian desert, California and Japan offer a richer suite of natural resources conducive to the existence of an affluent foraging economy. These two areas are also quite similar in that they are highly productive in acorns and salmon, upon which populations of both regions relied (Baumhoff 1963; Yamanouchi 1964). These two food sources were core resources in the economies of the affluent societies that existed in each region.

It is noteworthy that the term "Affluent Foragers" bears more than passing resemblance to the phrase "Original Affluent Society". The latter was used to describe small-scale, nomadic hunter-gatherers, and first appeared in the classic *Man the Hunter* volume (Sahlins 1968, 85). In *Man the Hunter*, band-size hunter-gatherer societies were characterized as having an egalitarian socioeconomic base, high mobility, minimal food storage, and no strong claims of territoriality. Sahlins advanced that these hunter-gatherers pursue affluence according to the Zen concept of "want not, lack not" (Sahlins 1972, 11). This, he argued, contrasts fundamentally with the "Galbraithian course" stressing material accumulation, which is "peculiarly appropriate to (modern) market economies" (Sahlins 1968, 85; see also Rowley-Conwy 2001).

In 1979, Koyama and D. H. Thomas applied the "Galbraithian" view of affluence in their modelling of foraging systems of complex hunter-gatherers, specifically coastal temperate foragers with larger group size and more sedentary lifestyles. According to Koyama and Thomas, complex foragers, as it were, "want much, enjoy much". Despite the superficial similarity engendered by also employing the term "affluent", their view of hunter-gatherer affluence differed markedly from that of Sahlins, highlighting a fundamentally different pattern of resource exploitation among foraging societies. These two visions of "Affluent Foragers" have since existed side by side, shaping substantive debates in hunter-gatherer studies over the past two decades.

This Volume

Studies in this volume focus not on the highly mobile foragers described by Sahlins, but rather on those affluent foragers that have typically been cast, since around 1985, as complex hunter-gatherers. At that time, the volume *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity* (Price and Brown, 1985) appeared, making the concept of "complex hunter-gatherers" a mainstay of archaeological discourse. Studies in the Price and Brown volume highlighted two aspects of complexity in foraging groups – economic and social. The economic aspect has been the subject of analyses and discussions initiated by Binford (1978, 1980, 1982), who tried to explain land use systems as directly conditioned by the spatio-temporal structure of the natural environment. For example, foragers existing in environmental contexts that contain dispersed and unpredictable small resource patches should predictably show more nomadic lifestyles. Conversely, groups with a relatively higher degree of economic complexity, typically including sedentism and intensive procurement and storage strategies, are typically observed in more productive ecosystems with a more predictable resource base, as is often found in temperate zones. Contributions focusing on the social aspect have tended to connect economic complexity with specific social structures. Testart (1982), for instance, has argued that social inequalities and stratification may result from complex systems of resource acquisition, sedentism and storage.

However, these discussions have failed to adequately explain the mechanisms that produce the great degree of cultural variability among foragers, and tend to simplify the multi-factored and dynamic processes involved in social and economic change among hunter-gatherers. For example, in the case of complex hunter-gatherers in temperate environments, if their foraging systems can be described as successful in that they could satisfy both their physical demands for nutrition and maintain environmental sustainability in their local area, then why did those systems disappear in many areas of the world? Apart from the monumental impact of modern industrialization, recent archaeological studies are revealing complex trajectories of socioeconomic change as a central feature of many hunter-gatherer histories. Among complex societies of the Holocene, this tendency is clear, as Uchiyama underscores with his study of cyclical phases of settlement spatial and economic structure in Jomon-period Japan. Although such phenomena have in the past often been explained as the result of inescapable climate changes or spontaneous cultural evolution, those factors certainly cannot and do not explain the entire picture. Nor could such limited factors explain why varied forms of complex hunting and gathering societies have existed throughout human history.

In the more than two decades that have passed since the original "Affluent Foragers" Symposium, the problem of explaining variability has become a primary theme in the study of complex hunting and gathering societies. For instance, at the Aomori Symposium held in 1998 as part of the 8th Conference on Hunting and Gathering Societies (CHAGS 8), the importance of historical factors was emphasized by limiting the study area; the proceedings were published as *Hunter-Gatherers of the North Pacific Rim* (Habu et al. 2003). Our symposium, however, has taken a global perspective, seeking nuanced and satisfying explanations for variability and change around the world. This project involves bringing into clear view the global commonalities in hunter-gatherer societies and their organization while emphasizing the local factors that play a critical role in shaping change or stability in each area. While the objective here is comparative, the over-arching goal is not to solely produce generalisations.

Looking back to 1979, environmental differences were thought to be a key factor for explaining the many different forms of hunter-gatherer societies evident in various times and places on the planet. However, it has been clear for some time that the issue is not so simple. It is now obvious that we need to focus more on studying the resource procurement and management systems of complex foragers as socially-constituted phenomenon, viewing these systems as composed of decisions and agendas, and not let ourselves be swayed by heavy-handed environmental determinism.

As a starting point for discussion in the ICAZ symposium, the organizers proposed one assumption – that any foraging society is not a closed system, but rather quite an open system in a variety of respects. A premise of the 1979 symposium was that foraging societies are/were small, self-sufficient and isolated communities and that explanations for their organization could effectively be sought through studying them in their isolation. However, no social group can be thought of as a simple, homogenous, and isolated subsistence system. Various components of such systems affect others, internally as well as externally with respect to both the natural and social environment. Regardless of scale, social systems – from predominantly egalitarian bands to stratified chiefdoms and states – display incredible external connectivity and interactivity via relations of trade, exchange, marriage, and territoriality management. These inherently social relationships clearly exert a great influence over even the most basic of subsistence activities. It would be folly to ignore the reverse, yet this volume is an attempt to push the sociality of hunter-gatherer lifeways to the forefront of the discussion. Clearly considerations of the role of environmental causality in structuring hunter-gatherer lifeways have had their share of the spotlight. The 2002 ICAZ session included a range of recent studies in diverse areas of the world, aiming to put a decidedly global spin on the results and findings of local archaeological fieldwork. It was to our great delight that an amazing diversity of contributors participated, including archaeologists, anthropologists and icthyologists hailing from six continents, united in their interest in moving beyond the original affluent forager model. We hope this research will act to stimulate the construction of a new theoretical framework in which to situate prehistoric foraging societies.

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Shuzo Koyama
Suita City Museum
4-10-1 Kisibekita,
Osaka 564–0001
Japan
E-mail: skoyama@idc.minpaku.ac.jp

Junzo Uchiyama
Research Institute for Humanity and Nature (RIHN)
335 Takashima-cho,
Kamigyo-ku,
Kyoto 602–0878
Japan
E-mail: junzo@chikyu.ac.jp

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2. Gunditjmara Environmental Management: The Development of a Fisher-Gatherer-Hunter Society in Temperate Australia

Heather Builth

Archaeological investigation of a volcanic landform occupied by the Gunditjmara of temperate Southwest Victoria, Australia, has provided evidence of aquaculture as the basis of a highly organised prehistoric socioeconomy. Manipulation of the landscape resulted in large-scale management of the shortfin eel (Anguilla australis) *ensuring perennial availability of this and other wetland resources. By the time of British colonisation, the Gunditjmara had developed a resource specialisation that formed the basis of sedentary settlement. In addition, seasonal trapping and preservation of the shortfin eel by smoking enabled a storage economy and facilitated trading. Landscape archaeology and archaeozoological evidence have led to a socioeconomic model of Gunditjmara settlement that contradicts previously accepted models of Australian Aboriginal societies. With resource management, control and preservation, this fisher-gatherer-hunter society exhibited all of the necessary conditions of social complexity. Archaeological evidence supports the existence of regional social stratification and hereditary chiefs as described in previously dismissed ethnohistorical accounts.*

Introduction

Archaeological evidence for the modification and management of a volcanic landform in Southwest Victoria, Australia (Fig. 1) by the indigenous nation, the Gunditjmara, reveals the physical manifestation of a highly developed socioeconomy and political organisation. This evidence supports the broader hypothesis of Lourandos (1977; 1980a; 1980b; 1983; 1984b; 1985; 1987; 1991; 1997) that indigenous populations of Southwest Victoria were "socioeconomically complex" as that term is usually applied to non-agricultural societies. This socioeconomic complexity was a consequence of activities undertaken by the society. A stratified hierarchy was the product of the resource control and material surplus, which in turn resulted from the technologically assisted exploitation of environmental opportunities offered by the local landscape. Not least of these landscape attributes was the presence of a river that functioned as a migration corridor for the shortfin eel *(Anguilla australis)*. The study of Gunditjmara socioeconomics has implications for our understanding of the role of anadromous and catadromous fish species in the development of human settlement, as discussed below.

Environmental and Archaeological Context

The temperate climate of Southwest Victoria has a marked seasonality, with the lowest variability in rainfall of all Victorian environments, from 660–860 mm per annum. Winters are cool to cold, mostly wet, and the plains near the ocean are prone to cold winds from the southwest. Average daily winter temperatures vary between 5 and 13°C. Summers are warm to hot and much drier; the average daily temperature ranges between 16 and 26°C, with days over 38°C not unknown (Lourandos 1980b, 28; CONTEXT 1993, 12). The specific area under investigation is the landscape that resulted from the volcanic eruption of Mt. Eccles in southwest Victoria approximately 30,000 years ago (Fig. 2). Covering 145

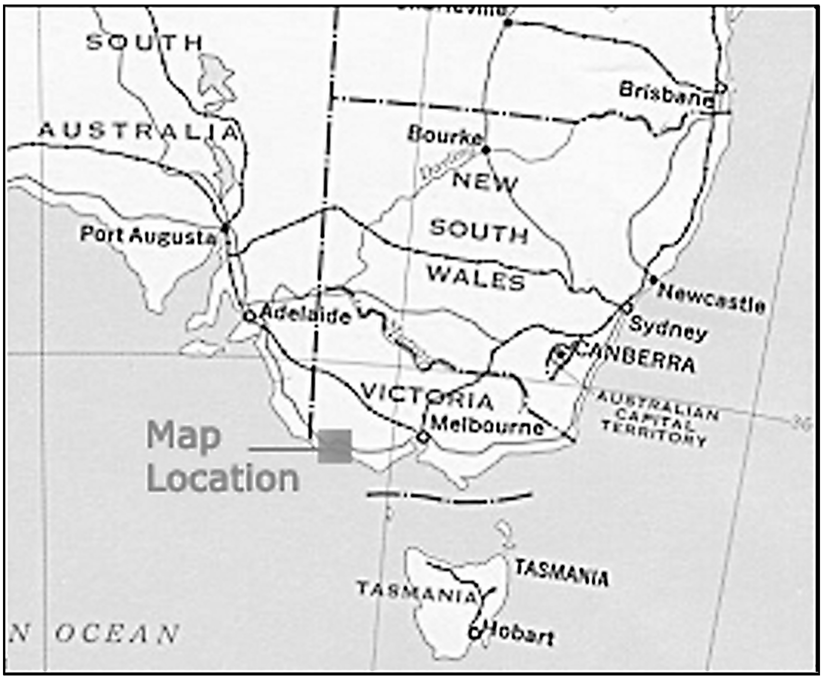


Fig. 1. Location of Mt. Eccles, or Tyrendarra, lava flow in Australia.

sq. km, the Mt. Eccles lava flow, known geologically as the Tyrendarra Flow and to the Gunditjmara as Budj Bim, consists of a matrix of weathered basalt juxtaposed with swamps and lakes bordered on the east and west by rivers (CONTEXT 1993, 13–15, 28–34; Joyce in AQUA 2001). The formation of wetlands within the varying pattern of wood and grassland has provided a highly biologically productive environment with a correspondingly high potential for human resource exploitation.

Archaeological structures evident throughout the landform consist of variously sized and designed stone circles. These c-shaped or u-shaped circular and semi-circular features have been identified as cultural constructions (Builth 2002b, 2002c; Coutts et al 1978; van Waarden 1990; van Waarden and Simmons 1992) in that they are composed of layers of movable basalt blocks with walls up to a metre high. They have been hypothesised to be the remains of dwellings (Coutts et al 1978; van Waarden 1990; van Waarden and Simmons 1992) and storage caches (Builth 1996, 2002b, 2002c). They often occur in clusters throughout the Mt. Eccles Lava Flow (Fig. 3). Other archaeological features are directly associated with past water bodies and apparently had a hydrological function. Such features consist of channels, modified and artificial, weirs, dams, and the remains of fish/eel traps (Fig. 4). The non-organic construction material used in these formations is basalt produced by the volcanic eruption, and is all that remains of the facilities.

There has been no direct dating of the stone structures and the length of time over which they have existed is yet to be ascertained. Limited excavations of stone dwelling remains in the late 1970s and 1980s were carried out in three separate areas on the Mt. Eccles lava flow. The presence of European sourced materials in one of these areas and the lack of stratigraphy led to the suggestion that they were of Aboriginal origin but a contact adaptation (Coutts 1977, 1982; Coutts et al 1977; Geering 1985, 3), though this suggestion is dismissed by Builth (1996, 2002b, 106–8). Two subsequent excavators have argued that similar structures were of precontact origin (Wesson 1981, 96; Williams 1988). There are many explorers' and settlers' reports of various types and styles of Indigenous housing constructed prior to the arrival of Europeans (e.g., Dawson 1881, 10; Robinson in Clark 1998–2000; Smyth 1872, 124–9; Lang in Godfrey 1994, 309). Williams (1984, 173) has stated that even though some construction of substantial huts continued after contact, "the use of 'villages' as a settlement form seems to have disappeared soon after first contact". From the northern part of Gunditjmara country it was observed that "[s]hortly after the Europeans came to occupy Victoria the natives ceased to build huts, and they no longer assembled in villages" (Smyth 1872, 128). In addition to villages having been directly observed by new settlers, historical documentation describes their purposeful destruction (Thomas in Bride 1898, 429–30).

On the Mt. Eccles and Napier lava flows, the availability of basalt lava blocks combined with springs, high rainfall, and the water run-off from an extensive lake/swamp complex to the north enabled the efficient exploitation of wetlands by the Gunditjmara. Eels combined

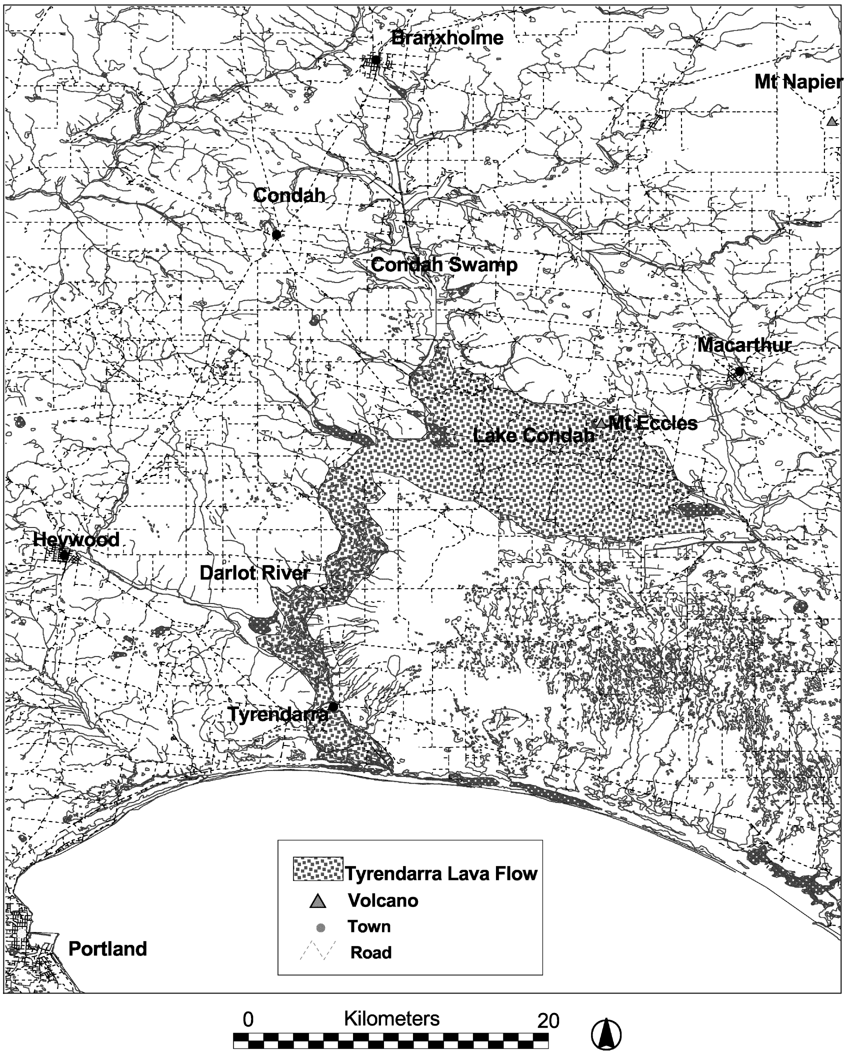


Fig. 2. Regional context of Mt. Eccles lava flow.

with other wetland resources, such as the tubers and roots of reeds and other swamp plants, fulfilled staple nutritional requirements. As a catadromous fish, the eels became abundant during seasonal migrations and are therefore capable of being efficiently trapped as they move to and from the ocean. The ethnographic record and archaeological evidence of villages (or groups of dwellings) almost always occur in Southwest Victoria in spatial association with eel/fish trapping facilities (Fig. 5)(Clarke 1998; Critchett 1990, 62; Geering 1985, 1986; Gerritsen 2000, 12, 15–20; Lourandos 1980a, 1980b, 1987, 1997; van Waarden and Simmons 1992; Williams 1984, 1985, 1988).

Anthropological and Historical Context

There has been much debate as to the type and nature of the social and economic practices in Southwest Victoria arising from the long term adaptation of aboriginal peoples to the resource-rich, well-watered and high rainfall region (Beaton 1983; Bird and Frankel 1991; Builth 1996, 2002b; Clarke 1994; Coutts 1985; Lourandos 1983, 1985; Presland 1977; Williams 1988). Lourandos' hypothesis states that local demographic pressures, population interaction, and/or incentives relating to prestige and status could have been the major social motivation leading to mechanisms of economic control (Lourandos 1980b, 400–403).

This debate continues in part because historical circumstances have ensured that very little was recorded of the nature of the sociopolitical organisation and cultural practices of the Gunditjmara. The early dispossession of the aboriginal people of Southwest Victoria has directly contributed to our present lack of knowledge regarding their prehistory (Coutts et al. 1977; Critchett 1990; Wolfe 1999). The environment of the Mt. Eccles lava flow had long ago attracted the Gunditjmara people, and their rapid

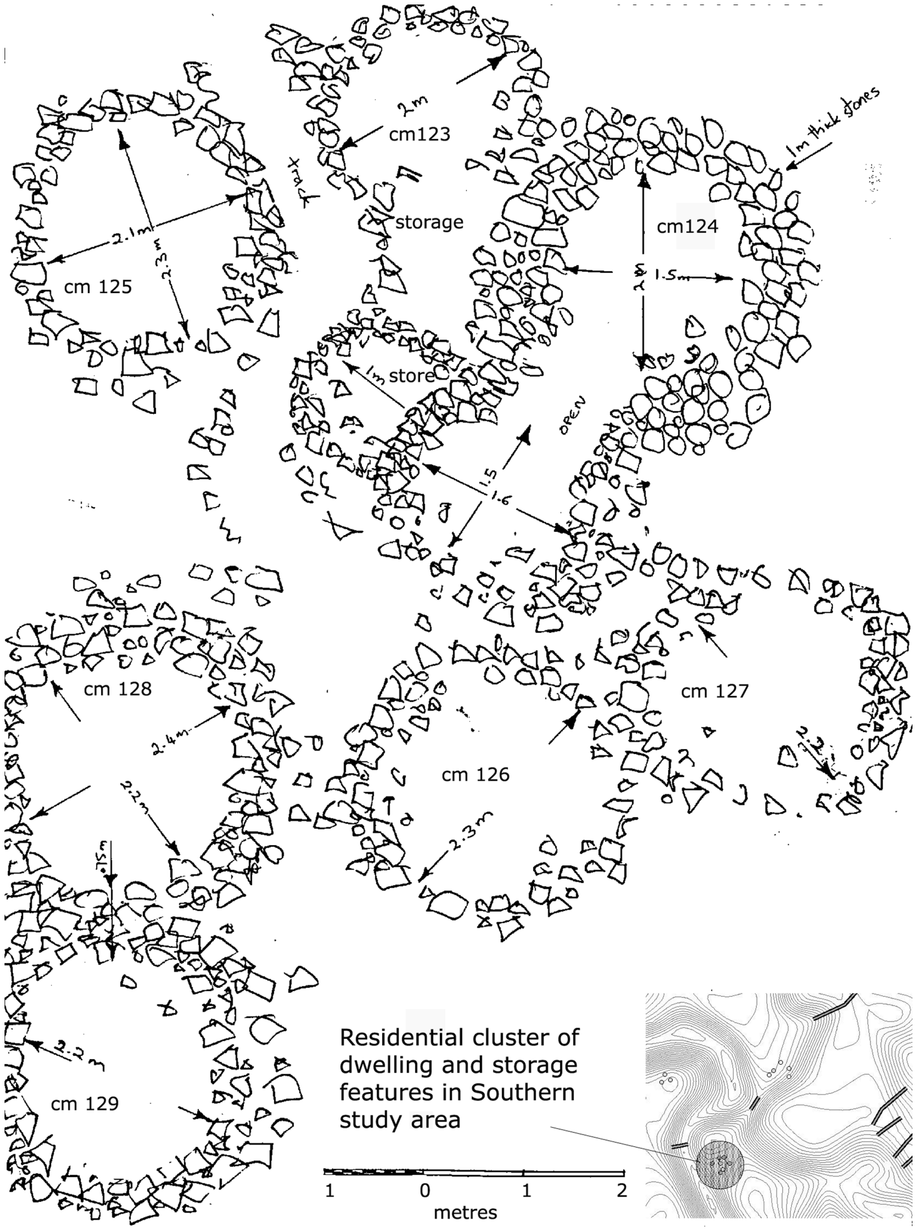
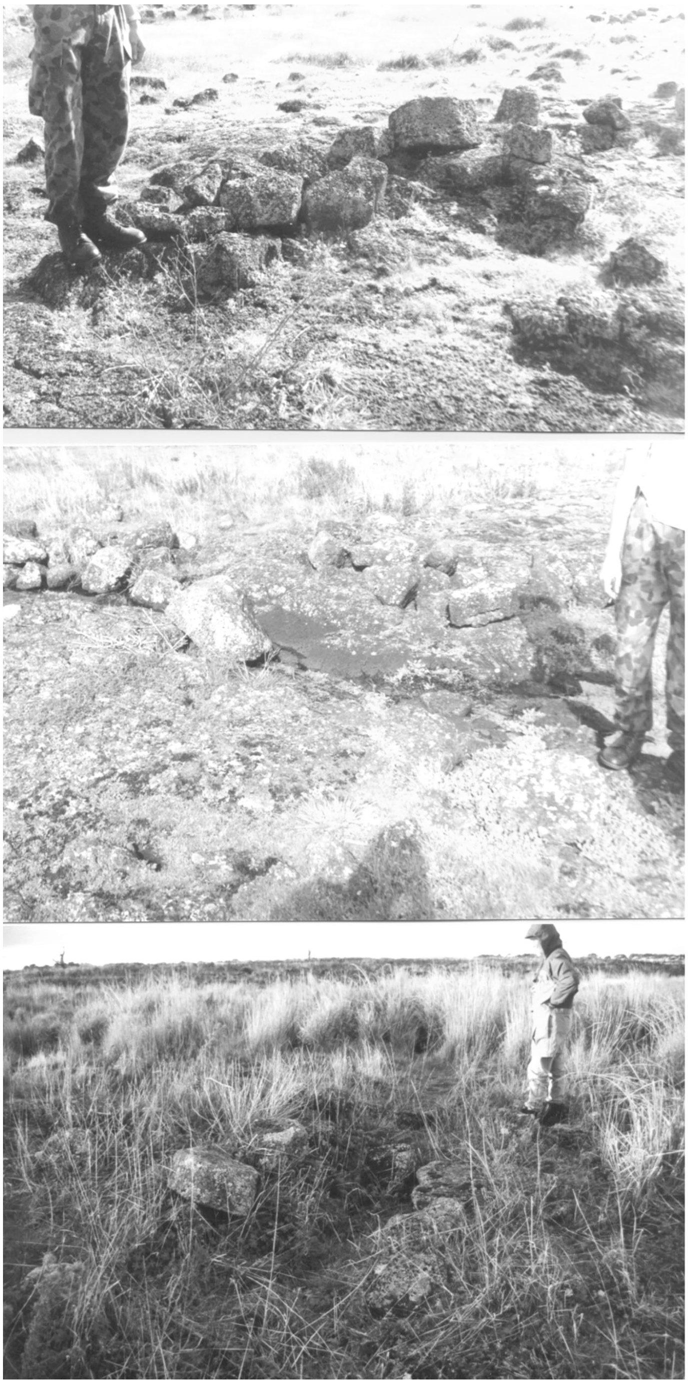


Fig. 3. A cluster of dwellings/storage remains in relation to weirs on lava flow.

and ruthless displacement in the southern regions of Australia by the invading British was due to the natural fertility of the country. The dearth of ethnohistorical material means that archaeologists and the relatively few surviving and often displaced Aboriginal families must piece together previous settlement patterns. Southwest Victoria was almost entirely occupied by European squatters by the late 1840s with a high price paid by the Indigenous population defending it (Cannon 1990; Christie 1979; Corris 1968; Critchett 1990; Kerley 1981). A lack of past anthropological studies, due to perceived limited ethnographic opportunities, has placed the emphasis of investigation into past Gunditjmara land use on an archaeological methodology.

Although limited, the accounts that do exist of pre-contact, indigenous patterns of land use in regional western Victoria confirm that their economic strategy was not analogous to the subsistence systems found in other parts of the continent (Clark 1990; Lourandos 1997). The volcanic eruptions have shaped the environment and affected the ecology significantly. The complex pattern of microenvironments coupled with their productive ecological attributes offered prime conditions for sedentism and high population levels. On a local level, appropriate technologies developed (Lourandos 1980b, 46–48). Ethnohistorical observations and subsequent research confirm the existence at European contact of an economy based on complex exchange systems (Lourandos



part of Dam6a

water behind

Channel 2

with water
trickle

Channel 3

11m x 1m
x 0.5m deep

linking 2
swamps

Fig. 4. Remains of some hydrological features on the landscape.

1980b; 1991; McBryde 1984) and reliance on fishing, especially eel fishing. Robinson (in Clark 1990; Clark 1998–2000) describes impressive eel weirs in Southwest Victoria used in large-scale resource extraction. There are also many accounts of substantial and permanent housing (Builth 2002b; Clark 1998–2000; Dawson 1881; Lourandos 1980b; Robinson in Clark 1990).

Studying the Gunditjmara Landscape: An Archaeological Methodology

Below, I present an archaeological investigation of Gunditjmara socioeconomic organization. To understand the nature of past Gunditjmara wetland management a methodology more appropriate to the local landscape than the traditional Australian archaeological method of excavation and analysis was considered necessary.

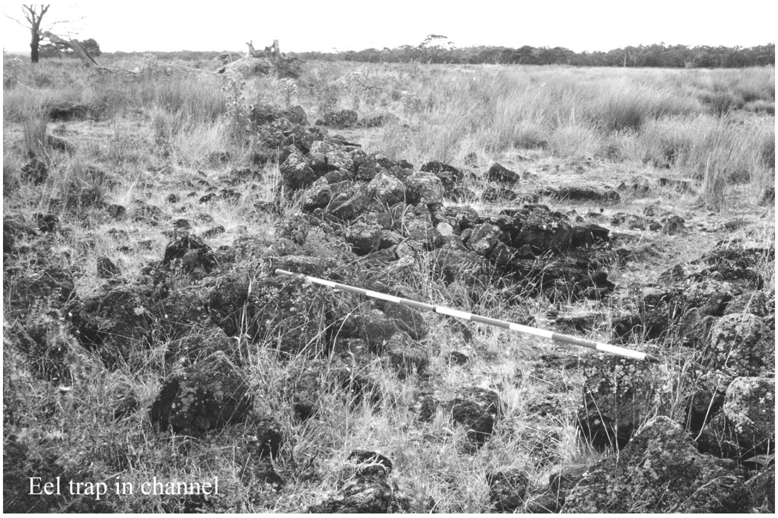


Fig. 5. The remains of a weir with eel trap.

Lourandos (1980b) had previously embarked on a landscape approach in his research into large-scale drainage systems to the northwest, attempting to gauge shifts in the intensification of resource exploitation and the relationship of these shifts to the prevailing socioeconomy. Evidence of large-scale environmental manipulation could easily be overlooked using small-scale excavation, and it is highly likely that this may have occurred during Australian archaeological studies (Head 2000; Lourandos 1980b, 353).

In this study a four-fold approach was undertaken. Three approaches were archaeological, acquiring data through primary research at a landscape level, an individual feature level, and a bio-molecular level respectively. A fourth approach was the inclusion of ethnographic information, past and present. Overall, the determination of relationships between the geomorphology, the structures and the topography was considered essential. The archaeological investigations incorporated the entire spectrum of remains from the single stone to the landscape level (Rossignol 1992). Analyses of stone sizes and their placement in the landscape show that the use of statistics and pattern recognition can provide empirical data to construct an argument that stone circles and eel traps are a cultural construction and can be differentiated from "structures" resulting from natural processes (Builth 2002c).

A rigorous inventory of the different types of archaeological resources in the study areas on the lava flow was carried out, and a spatial analysis of these structures was conducted to understand their typological relationships and determine their functions. The types of archaeological remains that have been identified include stone weirs, stone barriers or dams, channels, eel traps, dwellings, storage caches, culturally modified trees, mounds and artefact workshop areas. The landscape analysis employed a Geographical Information Systems (GIS) program to map, link and analyse the different categories of archaeology in this landscape (Aldenderfer and Maschner 1996; Gillings et al. 1999). One of the main aims of the spatial analysis was to determine the hydrological regime and its relationship to the functions of archaeological structures in direct association with past water flows and wetlands.

Superimposing an archaeological layer on the topography, which had been surveyed by a total station theodolite and reduced to a Digital Elevation Model (DEM) using GIS, provides a means to investigate the function of features by analysing intra- and intersite associations. The resulting DEM is accurate to 0.1 m in areas of archaeological or terrain/drainage significance. Past water flows were simulated using GIS to recreate precontact swamp levels. Functions of the archaeological features were accordingly ascertained. Relationships between weirs/eel traps and swamps were established, and relationships between dwelling remains and the hydrologic features were evident. This provided a clear demonstration of the nature of the wetland modification and resource management undertaken by the Gunditjmara. These results were combined with other data sets derived from both biomolecular and statistical data and a clear picture of the extent of landscape management and resource control and processing emerged (Builth 2002a, 2002b).

These archaeological features were investigated on the premise that they were inter-related and formed part of a past social landscape. There has been a dearth of archaeological research into past Australian Aboriginal ethnoarchitecture and its meaning in southern temperate regions. Aboriginal architecture incorporates domestic places and specific activity zones, including cooking sites and storage areas. The landscape becomes the stage for

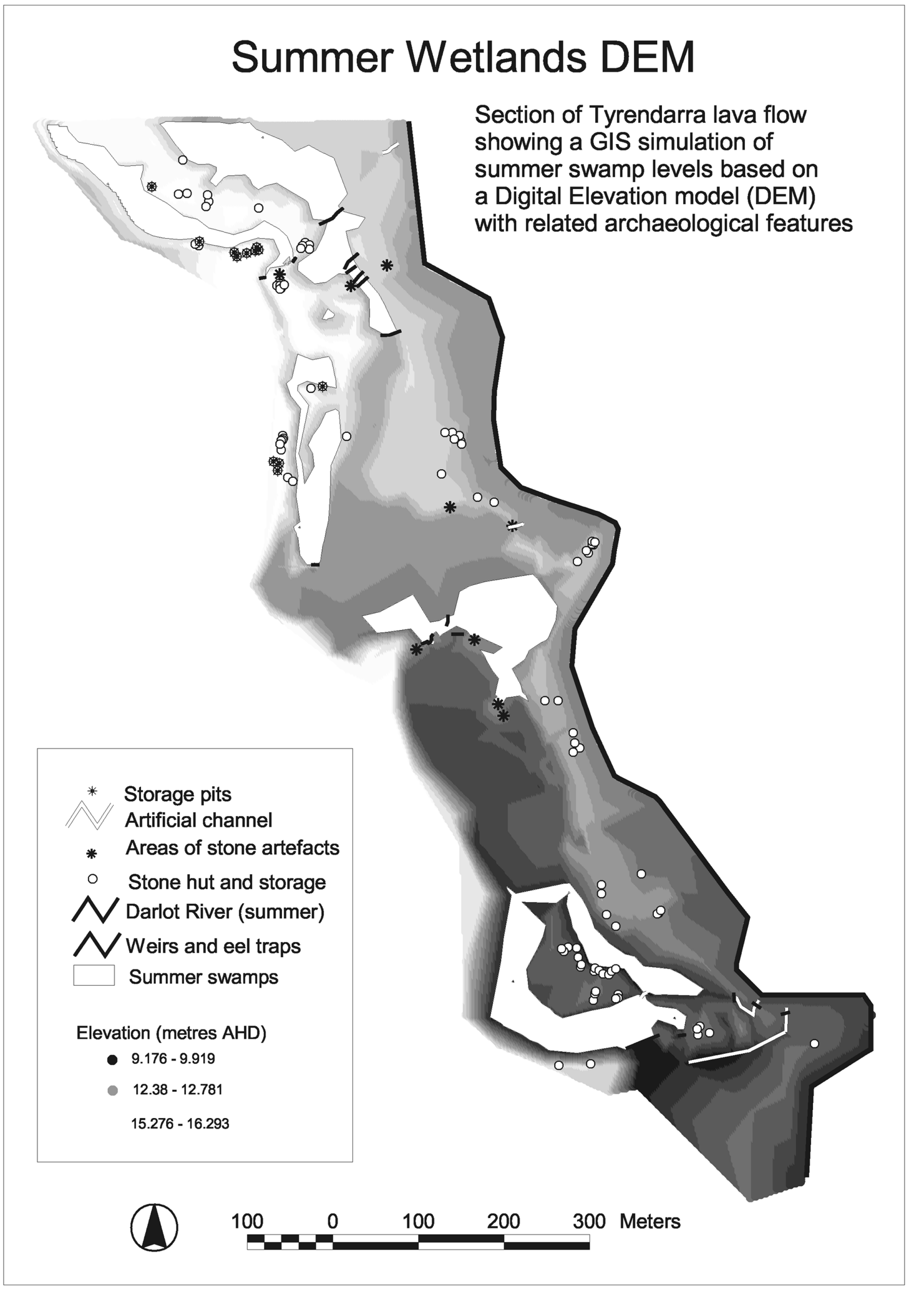


Fig. 6. Digital Elevation Model of study area with summer wetlands as simulated by GIS following cultural modification, along with other archaeological features.

settlement activities and incorporates day-to-day events transacted through a network of connections and relationships with surrounding places and kin; the structures represent a material extension of this in response to climatic and social factors (Memmott 2000, 188).

Interpretation of Archaeological Record

Through the use of GIS it was evident that some of the archaeological remains associated with the hydrological regime proved to be weirs and dams for holding back water in order to create a series of waterbodies (Fig. 6). The boundary river, Darlots Creek, has had culturally constructed connection channels excavated from it to bring young eels, during their spring migration from the ocean, into the prepared wetlands that were extended spatially and temporally by damming. These eels would remain in the swamps for the next 20 years or so before returning to the ocean in autumn to spawn and die (Gooley et al. 1999). Other channels – natural, modified and artificial – ensured the water flowed between the swamps

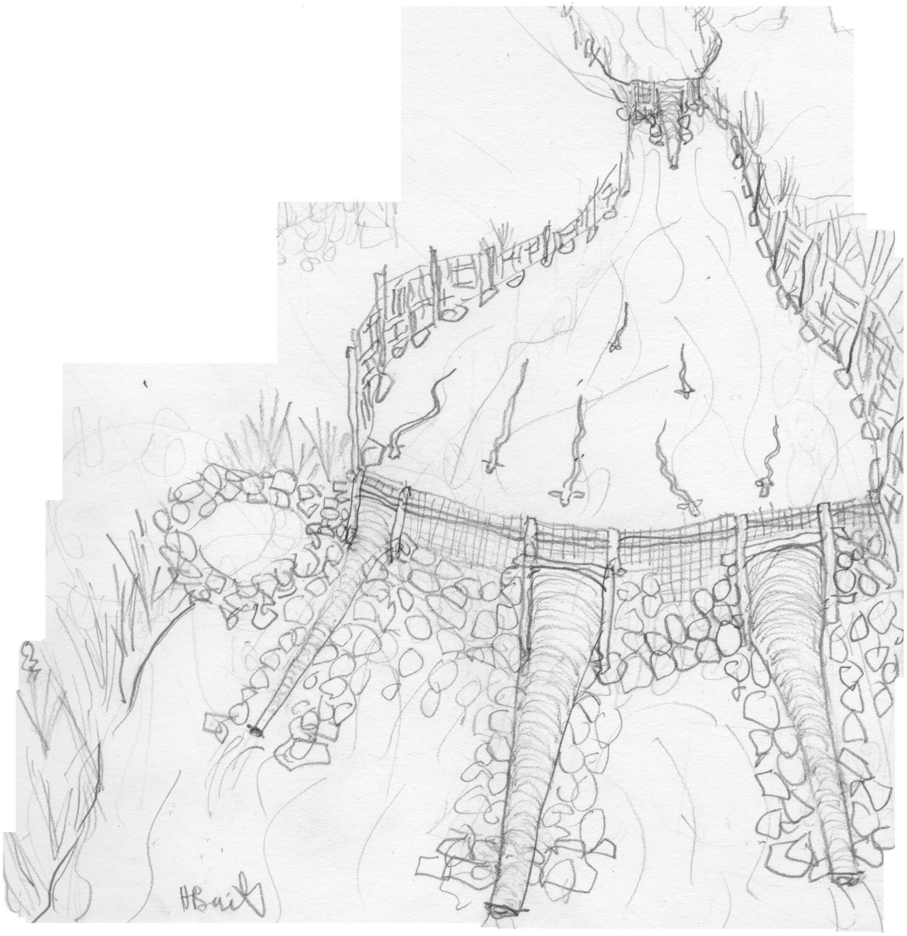


Fig. 7. Reconstruction of basketry funnels in weirs across channels to trap eels (illustration by H. Builth).

and continued downstream to link other swamps. Thus this system or series of systems became an integrated part of the landscape of the lava flow.

The main use of the manipulated wetland system was for the growing of young shortfin eels to maturity, though as a result other wetland resources would also have been available in the swamps beyond their normal seasons. Archaeological investigations have confirmed that water from the local catchment and further upstream was controlled (diverted and dammed) by the construction of dams/weirs and channels along the entire length of the 40 km lava flow. Ethnohistorical materials confirm that the Gunditjmara Aboriginal people constructed stone, wood and lattice weirs to exploit the shortfin eels throughout this landform (Coutts et al. 1978; Worsnop 1897). Eel-trapping weirs were used in association with woven basketry funnels (Fig. 7).

The weirs and stationary traps occur in physically appropriate locations along the kilometres of channels that run mainly north to south along the length of the lava flow parallel to the boundary river. These channels have been modified or constructed to enable continual water flow during the eel migrations (Builth 2000). The eels were either speared in the waterbodies on a daily basis or trapped in large numbers during their migration back to the ocean via the channels. The attraction in trapping the migrating mature eels lies in the observation that in Victoria the shortfin species have more than 55% greater fat content while migrating as compared to feeding eels. Feeding eels had a fat content of 12.6% and migrating eels 19.0% (Sumner et al. 1984).

The importance of eel exploitation constructions resides also in the social and spiritual realm. In consultation with contemporary Gunditjmara families who identify with the Lake Condah Mission, some direct cultural continuities have been verified in the use of eel traps. Ownership of particular eel traps, including their use and maintenance by certain families, has continued through to the present (personal communication Theo and Keith Saunders, Johnnie Lovett; Puunyart 1988). In addition, continuing strong cultural connections linking both physical and metaphysical aspects of the stony rises and Mt. Eccles are evident.

In the 40 ha southern study area, 72% of the dwelling/storage remains were between 2 and 23 metres from the high water mark of the wetlands. As these archaeological remains were not solely spatially associated with the eel traps (which were only utilised during the autumn migration) it was deduced that the wetlands were the main focus of year-round occupation. The spatial relationships between the dwelling remains, the wetland edges, and the eel traps revealed that they were positioned to be occupied for at least three of the four seasons, being above the high water mark in floods yet containing water in all but the most severe droughts (see Fig. 6). The nature of the topography and lava flow ensured that land adjacent to wetlands was always well drained. Thus, there is strong evidence for year round occupation on this landform with the wetlands as the focal source of nutrition for the Gunditjmara.

In summary, the direct ecological consequences of the Gunditjmara landscape modification were (1) the artificial spatial and temporal extension of wetlands and their associated ecosystems, producing an increase in resource productivity, (2) an enhanced eel fishery for both the short and the long term, as management of elvers was an investment for their future production, and suitable environmental conditions ensured, eventually, greater numbers for spawning, and (3) the continual parallel channels spatially extended eel habitat and facilitated their migration south to the sea.

Biomolecular Evidence

Archaeozoological research has produced evidence indicating that on the Mt. Eccles lava flow huge numbers of shortfin eels were grown and trapped during the autumn migration, and that these were processed and preserved by Gunditjmara for storage or trading (Builth 2002a). Smaller stone circles adjacent to the house sites were previously hypothesised by the author to be storage caches (Builth 1996). It was observed that the existence of mature *Eucalyptus viminalis* (manna gum) trees occurred in close proximity to eel trapping and residential sites. After examination of the trees it was considered possible that a large number of hollow trees had been culturally modified. Naturally hollow mature trees were subsequently found to have been modified to gain entry into, and use of, their hollow. Attributes were collected in an attempt to quantify this and to ascertain their function. A statistical study was carried out on 51 trees (Builth 2002b).

In addition, spatial analysis was carried out within a 5.2 ha study area that included 30 culturally modified trees (CMTs), 15 unmodified trees, 51 stone dwelling remains and two eel-trapping complexes. The traps are situated in narrows between water bodies that act as growing areas and/or live eel storage locations. The traps also perform the function of dams in what becomes a migratory channel during the autumn rains. The position and proximity of all of these elements to the simulated high water levels was plotted. The whole study area extended no further than 70 metres from the water.

Results include the following:

- 17% of modified trees are found within 20 m of Eel Traps
- 0% of unmodified trees are found within 20 m of Eel Traps
- 67% of modified trees are found within 23 m of stone dwellings
- 73% of modified trees are found within 15 m of the water edge
- 82% of stone dwellings are found within 15 m of the water edge
- 100% of stone dwellings are found within 26 m of the water edge

It is also noteworthy that all trees within 20 metres of the two eel traps have been modified. These CMTs represent 17% of their total number, and at the same time 67% of the CMTs are found within 23 metres of stone dwellings. However, as 20% of stone dwellings are also found within 20 metres of the eel traps, there is obviously some overlap of CMTs.

It was concluded that there was a bimodal utilisation of the CMTs. It is proposed here that CMTs in proximity to the dwelling remains had been used as cooking or baking hearths. CMTs in spatial association with dwellings that were examined contained pieces of basalt that were interpreted as heating stones. A function of other CMTs in close proximity to the eel traps may have been for the purpose of smoking, and hence preserving, eels, since such trees did not contain heating stones. It is further hypothesised that the different uses of CMTs reflects a gendered division of labour, with males being responsible for the eel smoking.

Ethnographic documentation informs us that the tubers and corms that formed the staple vegetable requirement for starch and carbohydrates required baking in earth or pit ovens. The hearth fire was the responsibility of the women (Dawson 1881, 14; Pyne 1991, 88, 113; Roberts 2000, 21; Tindale n.d.). The tubers were generally cooked slowly overnight for consumption the next day in "...native ovens [that] are always formed by digging deep holes in the ground" (Dawson 1881). On the lava flow it was impossible to dig a baking oven. For this reason it would have been necessary to find an alternative facility with a suitable depth of sediment for baking. Large mature hollow trees would have sufficed for this purpose, and considering the seasonal strong winds, also provided a natural shelter for the oven. Clearly naturally hollow trees in the study area had been modified to gain entry into, and use of, their hollow (see Fig. 8 and 9) (Builth 2002a, 2002b). There is no ethnographic documentation of smoking eels but a sketch from southern Australia, most likely Victoria, reveals the use of fire in a hollow tree by a male (Fig. 8).

Biomolecular analysis was employed on residues contained in sediment located within two CMTs not associated with dwellings and not containing heat stones

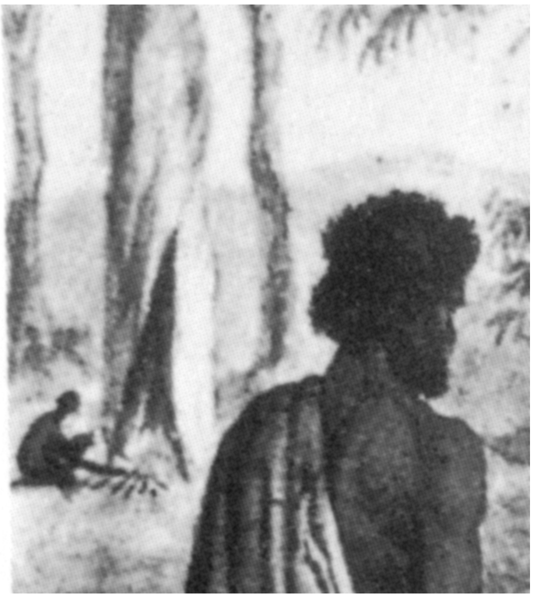


Fig. 8. A fire burning in a hollow tree and a man inserting prepared food for cooking or smoking but not baking (adapted from Blandowski 1857:18).

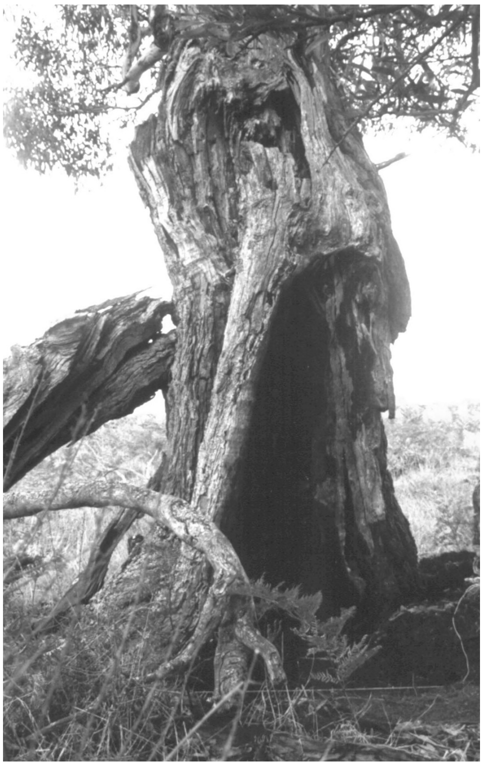


Fig. 9. Culturally modified Eucalyptus viminalis *found to contain eel fatty acids.*

to test for the presence of eel lipids and fatty acids using Gas Chromatography and Mass Spectrometry (GC/MS). The residues contained particular unsaturated fatty acids, 16:1, 18:1, 18:2, 20:4, and 20:5, cetyl alcohol and cholesterol. The biomolecular evidence supports the hypothesis for smoking. A freshwater aquatic animal was given as the most likely source for the residues. Evidence provided by gas chromatography (GC) and GC/mass spectrometry (GC/MS) analyses is consistent with the sediment residues having their origin in the smoking of eels (Fankhauser 2001, 1). Smoking is a universal means of preserving food, especially for oily fish like eels and salmon. Sphagnum moss, which is the basis of peat, can also fulfil this role. As indicated by Jones (2001), carbonyl groups help preserve the fish by tanning the skin, making it unappealing to bacteria; exposure to wood smoke has exactly the same effect.

A positive identification of eel lipids supports the hypothesis for smoking and therefore preserving and storing this species. This conclusion fits with formerly identified storage caches (Builth 1996, 2002), supporting the argument for highly organised exploitation of this species. This rare archaeozoological evidence of the shortfin eel in Australia is a significant result in support of a complex Gunditjmara economy.

Social and Economic Implications for Fisher-Gatherer-Hunter Societies

A number of factors have been posited for the development of social complexity amongst hunter-gatherer groups (Ames and Maschner 1999, 24–29). Hayden (1996b, 56) has stated that in relation to the Northwest Coast of North America there exists "a strong relationship between the abundance of fish resources and socio-economic complexity". Following investigation into the socioeconomies associated with the Fraser River catchment of British Columbia, Canada, Hayden (1992, 542) concluded that technological innovation a key element in the social change from generalised to complex societies. Other factors seen as important specifically for fisher-gatherer-hunter groups include increased abundance of resources and a reliance on resources less vulnerable to overexploitation. These conditions could be achieved by storage or other means such as aquaculture.

There is a perception that as archaeologists we may have underestimated the socioeconomic capacity of past fisher-gatherer-hunter societies to exploit their environments, particularly in relation to quality resources such as catadromous or anadromous fish species (Bernick 1998; Coles 1992; Coles et al. 1999; Lutins 1992; Pedersen 1999; Pedersen et al. 1997; Schalk 1977). This has not been the case on the Northwest Coast of North

America where the connections between salmon procurement and its preservation have been firmly linked to the socioeconomic evolution of these Native American societies (Ames and Maschner 1999; Grier, this volume; Hayden 1992, 1996a; Matson and Coupland 1995).

The ownership, or privileged access to, resource localities was a pronounced feature of cultures of the Northwest Coast as well as of every other ethnographically documented group of complex hunter/gatherers with which I am familiar (see also Hayden 1992, 546–7). Significantly, Hayden cites the building of platforms adjacent to fishing locations and weirs as a demonstration of ownership, and as such, the owner could oversee its use, and thereby retain control. Similar platforms were observed by Dawson and Robinson in Southwest Victoria, Australia, and the latter was told these were family-owned (Robinson 1841, quoted in Kenyon 1928, 147; Dawson 1881, 95; Builth 2002b, 56–68). Recognition of claims to ownership was contingent upon others having enough food under normal conditions. The interplay between resource abundance, technology, and systems of ownership is expressed specifically in the development of Gunditjmara eel aquaculture, but can also be cast more generally in relation to the forager-collector continuum presented by Binford (1980). Davidson makes the point that "a shift along the continuum can only happen in two ways: by a change in the distribution of resources in time and space or by some change in the abilities of humans to cope with the pre-existing unevenness of resource distribution" (Davidson 1989, 77). Archaeological detection of landscape modification on the Mt. Eccles lava flow that resulted in the artificial extension of wetlands both in time and space for the purpose of exploiting eels amounts to a systematic social and technological intervention into the natural situation that provided the basis for a shift to greater organizational complexity, as measured along Binford's (1980) scale.

Conditions for Resource Specialisation

Schalk (1977, 228) presents a convincing argument that "environmental conditions determine the degree of specialisation". More general adaptations tend to exploit resources roughly proportional to their actual abundance in the environment, which makes them "indiscriminate consumers" (Earle 1987). Generalisation in hunter-gathering is at the expense of efficiency, but favours flexibility. It works well in environments of low stability and productivity, such as those of arid or semi arid Australia. Specialisation is favoured in environments that are the opposite in these respects and is associated with highly stable environments and high productivity (Schalk 1977, 228). Specialisation implies less capacity for coping with instabilities, but "it implies increased efficiency in the exploitation of fewer resources". This is seen as a major evolutionary advantage. Osbourne states that "an increased utilization of aquatic resources, would therefore favour and result in specialization" (Binford 1977). The link between the biological capabilities and habits of the species, its ecological requirements and the human organisation of management practices to carry it out forms the basis for a specialised economic system (Galvin 1987, 120).

It is put that particular environmental and ecological attributes act as an incentive to initiate a cultural response in the form of technological innovation leading to economic efficiency. Economic efficiency permits both higher population densities and the production of a surplus to support a non-subsistence sector of the population. Economic interdependence resulting from specialised production and distribution of food and crafts is both the cause and the effect of larger societies, which become economically intertwined by food exchange as real energetic systems (Earle 1987, 64). Specialisation arose in the Northwest Coast groups as part of a shift in household organisation towards accomplishing complex simultaneous tasks (Matson and Coupland 1995). In addition, exchange through regional interaction spheres, such as the periodic regional gatherings, would have encouraged specialised production, not just in individuals but also households.

Fisher-Gatherer-Hunters Globally

It seems plausible that when hunter-gatherers were faced with the choice of cooperative action or sustained mobility, they sometimes judged mobility to be the greater risk and selected behaviours that promoted communal endeavours beyond the immediate family unit (Jacoby 1999, 12). The most efficient use of cooperative action for coordinated labour, Jacoby (1999) claims, is the exploitation of spawning fish, including eels. Of the fisher-gatherer-hunter societies that were compared, all had supporting archaeological evidence to show the groups concerned had relied on weirs and traps for resource capture during migration runs. There was great cross-cultural similarity in the design of the funnel-shaped woven traps that were inserted into the weirs (Bernick 1998; Builth 2002b, 275–300). However, few studies examined the socioeconomic and political implications of the use of the technology.

Pedersen's studies (1997, 1999) concluded that settlements on the Danish Coast were generally founded on eel weir sites; and the exploitation by weir and management of other spawning fish species supported the claim that socioeconomic changes resulting in a complex society had occurred (Erickson 2000; Foster 1999). The situation in New Zealand is analogous with Southwest Victoria in that there are indications of landscape modification, the use of weirs and woven traps, preservation, storage and an altered socioeconomy as a result (Anderson 1988; Barr 1998; Firth 1959).

Specialisation in exploiting spawning fish that lead to socioeconomic development was recently identified in a culturally modified landscape in Bolivia and featured extensive pond constructions dammed by weirs (Erickson 2000, 192):

> "Using this simple, but elegant, technology, the people of Baure converted much of the landscape into an aquatic farm covering 500 km^2. Rather than domesticate the species that they exploited, the people of Baure domesticated the landscape. The fish weirs and ponds produced abundant, storable, and possibly sustainable yields of animal protein. Thus, they were able to sustain large dense populations in what many would consider a marginal environment" (Erickson 2000, 192).

The Bolivian fisheries share parallels with the Gunditjmara land use:

> "Although individual weirs could operate independently of other weirs, the presence of an integrated network of causeways, canals, weirs and ponds suggest a higher order of water management. As a permanent food-producing infrastructure, the weirs must have been valuable real estate. The networks of causeways and canals may have promoted communication and alliances between individual communities exploiting the fish weirs. Groups in the Colombian Amazon jealously protect and guard riverine fisheries, valuable resources that are owned and inherited by clans and chiefly lineages" (Erickson 2000, 192).

Increasing control over the landscape appears to have promoted a new form of social dynamic based in exchange or intergroup cooperation. In New Zealand an intricately organised exchange network, including oils, seal meat, preserved eels, and other commodities, made settlement possible by spreading "widely desired but spatially restricted resources throughout the region" (Anderson 1988, 99–101).

Hunter-fisher settlement patterns have been affected dramatically by the employment of fish weirs – not in the least because of the time and seasonal constraints necessitated by their construction, repair, and utilisation (Lutins 1992, 4). They required an investment of energy to construct and maintain, and a high turn-over of fishers during the actual operation due to the abundance of migratory fish coming through and the physical demands of emptying the traps and killing the fish (Hayden 1992, 533). This technology was therefore designed to cope with a brief but massive influx of fish, unlike other methods that were more suited to one person catching what they could or needed. The capacity for surplus resource production and the social and economic implications of coordinated effort must not be overlooked, particularly in the requirement for a cooperative and organised energy investment to obtain the right materials, build the weirs and traps, organise the harvesting of the catch, and distribute or preserve the excess catch. There were rights to the weirs and the harvesting. It is also evident that particular groups and families in control of locations with greater fish population can become resource rich (Hayden 1992). Social and economic consequences arise from the opportunity to either preserve the resource for storage, trade or use surplus resources to host other groups. These actions may directly lead to social stratification and specialisation within a group, and have been implicated in the development of cultural complexity (Arnold 1996a; Earle 1987, 1997; Hayden 1992, 1996a).

A consideration of the cross-cultural use of fish weirs indicates that human groups who employed them demonstrated a similar trait: they were opportunistic and accordingly developed appropriate technology to make use of the opportunities that were available. Many different groups have independently worked out the most efficient means of anadromous and catadromous fish capture (Bernick 1998). The construction materials are locally procured and often owned and controlled, as are the weirs and their locations. It is a logical process from trapping to the preservation and storage of surplus resource.

The Social Functions of Storage

The nature and origins of social inequality are directly linked to environmental opportunities and aboriginal adaptations. This statement presupposes that the ecological characteristics of a landscape provide the impetus for social changes that occur in the people that occupy it (Hayden 1992, 4, 9). North American research on social complexity confirms that it is dependent on "the richness and nature of the resource base and in particular that it is dependent on the ability to produce surpluses" (Hayden 1996a; Owens and Hayden 1997, 123). Economic efficiency permits both higher population densities and the production of a surplus to support a non-subsistence sector of the population. Economic interdependence resulting from specialised production and distribution of food and crafts is both a cause and effect of larger societies, which become economically intertwined by food exchange (Earle 1987, 64). The function of storage bypasses the fluctuations in natural productivity levels, changing resource availability from being environmentally to socioculturally dependent. Storage "has been promoted as playing a critical role in the transformation of generalised to complex hunter/gathering societies" (Hayden 1992, 540). It has been regularly argued that storage has instigated sedentism, private ownership, and social inequality (e.g., Testart 1982).

Storage of fish depends on technological innovations being necessary to extract greater quantities in spatially constricted areas and over shorter periods of time (i.e., weirs, traps, nets, seines, etc.). Other technological requirements concomitant with fish storage are facilities utilised in processing like drying racks, smokehouses, baskets, storage pits, and/or storage houses. Such an investment would not be feasible or practical except in the case of populations storing very large quantities of fish (Schalk 1977, 232). Storage therefore can be seen as an outcome of changed resource and social conditions. Significant organisational changes occur in cultural systems associated with the implementation of a storage strategy, modifying the entire fabric of a subsistence system. Hayden (1992, 541) believes that "curtailing the obligatory sharing ethic" that is a trait of generalised hunter-gatherers occurred simultaneously with the adoption of preservation and storing techniques. Obligatory resource sharing would have acted as a deterrent to investing energy in the preparation and activities required for storage, as the stored resource would be easily appropriated.

Cultural Advantages of Eel Exploitation

Eels, as catadromous fish, spend from 10 to upwards of 20 years growing in the same fresh water body before returning to the ocean. As such, reliable access to this resource on a year-round basis is ensured. For this reason Australian Aboriginal societies, who had based their socioeconomy on the exploitation of eels were at a considerable advantage when compared to groups reliant on anadromous species like salmon. The wetlands acted as live eel storage that could be exploited on a daily basis. This means that preservation and storage were not as critical as with people reliant on salmon.

The similarity of the technological design of weirs and traps used to exploit eels can be seen to include the continent of Australia, but was also shaped in design and style by local terrain and drainage conditions. For all Australian groups, and indeed for groups worldwide, that employed stationary weirs for eel exploitation, advantages were accrued in many respects, including:

1. in terms of nutrient value, no other fish species could compete with the autumn silver eels
2. they can be easily and efficiently caught in large numbers
3. they can be easily preserved by smoking and stored
4. ownership of fixed stationary weirs excludes others from using the same sites

Pederson's (1997) important summary of research on Mesolithic and Neolithic eel weirs and traps in Denmark and their effects on the population and settlement patterns states the situation more broadly:

> "For many years, the traditional view of the Mesolithic has been of a period in which an extremely hand-to-mouth life was led in harmony with nature. This vision has proved harder and harder to preserve as archaeological evidence for the actual conditions then has gradually expanded. With the studies of the Early Stone-age fish weirs from the Halsskov area the notion has finally to be abandoned. Instead, society then had considerable organizational capacity, and people were very well able to manipulate the natural resources such as the trees of the forest. This new evidence undermines the familiar views of social development in the Stone Age in northern Europe and means that the transition from hunting to farming was hardly as revolutionary as hitherto thought" (Pedersen et al. 1997).

In summary, as with elsewhere, the economic changes that had taken place on the Mount Eccles lava flow as a result of exploiting eels by developing fixed weirs thus provide a basis for reconstructing the socioeconomic and sociopolitical structures that also evolved in this context.

Migrating Eels

The changes that occur in lipid content in growing eels (Sumner and Hopkirk 1976; Sumner et al. 1984) are significant when considering that their highest fat content is reached just prior to the annual autumnal migrations of mature individuals. This is therefore the optimum time for their exploitation from a caloric content viewpoint and the drive to maximize high-energy fats and oils in the resource. Capture and preservation of eels, therefore, at this particular point in their lives would justify the great investment of human energy required for their harvesting and processing.

The average caloric value of over 180 kcal/100g wet weight is nearly twice that of tuber staples. Humans require at least 1g of essential fatty acids (EFA) per day and 71 g of whole eel can provide this daily requirement. Linoleic acid (C18:2) of 7 g per day is considered highly desirable and 1.2 kg of whole eel, or 2200 kcal for an adult male, can supply this (Leach and Davidson 2001). This high proportion of body fat in eels means that it is possible to survive on this source of food alone. It has been recently realised that successful colonisation of new islands in the Pacific, and certainly some parts of New Zealand, may have been largely dependant upon the availability of regular supplies of fat. In areas where carbohydrate foods were not available, or could not be grown because of climatic factors, permanent habitation would be impossible unless rich sources of fat could be found to contribute at least 70% of daily energy requirements. In such a quest, eel could be of paramount importance (Leach and Davidson 2001). As suggested, *Anguilla australis*, due to its nutritional attributes, has the potential not only to enable the colonisation of new areas but also allow sedentary settlement of the people organised for its exploitation.

Gunditjmara and Eel Exploitation: Socioeconomic Implications

Preparation for eel trapping in the study area consists of either constructing or modifying channels to direct water and eels, building the stone foundations and organic component of the weirs, and weaving the reed funnels that are required. Preparation for processing the eels by smoking involved producing suitable facilities by accessing and enlarging hollows in *Eucalyptus viminalis* trees. The modifications and associated infrastructure represents a huge investment of energy and time. However, there were social benefits resulting from environmental and ecological manipulation. These included:

1. minimum travel required to access adequate resources
2. efficiency in resource procurement and surplus production
3. the production of large amounts of a highly nutritious and oily food that could be processed, preserved and stored, facilitating exchange and specialisation
4. larger populations could be fed and accommodated, so higher population density was possible.

The benefits, as stated above, have socio-cultural implications for Gunditjmara and the region generally. It could be argued that one consequence of these social developments was a requirement for leadership to protect the community and its infrastructure, possessions, and resources. Hayden (1996b, 56) sees the rise of individuals to positions of privilege in the community as directly relating to the "resource characteristics and their relation to human populations... especially the abundance, distribution, reliability, and vulnerability to overexploitation of resources".

That a large population must have been present on the Mt. Eccles lava flow can be supported by the claim that a large number of people were required to process the catch during the migration period, the high density of trap locations throughout the lava flow, and the hundreds of stone dwelling remains. Residents were predominantly sedentary in areas of this infrastructure, and their residency united them as a social group and providing a means to control access to resources and all forms of property. "Sedentary peoples own and control property; they inherit it; they have rules about it; their social organizations are profoundly affected by property" (Ames and Maschner 1999, 25).

The Role of Chiefs or Headmen in Southwest Victoria

A significant connection has been drawn between specialisation, exchange and complex societies (Brumfiel and Earle 1987, 2). On the Northwest Coast of North America it is recognised that resource specialisation, particularly the processing and storing resources, allows sedentism or semi-sedentism, producing social and economic changes that can result in social stratification and the formation of powerful hereditary chiefs (Ames and Maschner 1999, 24–29; Hayden 1996b, 56). It is suggested here that the ecological and resource opportunities available in Southwest Victoria, as in the riverine areas of the Northwest Coast of North America, provided the opportunity for indigenous societies to also develop more complex social and economic systems that ultimately included hereditary Chiefs or Headmen. The ability of political leaders to organise a more effective subsistence economy is considered the *raison d'etre* of powerful leaders. Powerful, centralised leadership is seen as developing in environmental and demographic contexts where effective economic management is either necessary or especially beneficial (Brumfiel and Earle 1987, 2).

One means of family power differentiation is through resource surplus and control. Ethnographic and ethnohistorical accounts of eel weirs and traps in this part of Victoria describe these as having been family owned. This is in addition to broader clan ownership, as amongst the traditional owners from Lake Bolac to the northeast who had achieved a fearsome reputation through demanding others to obtain permission to pass through their country or share their eel harvest in autumn (Kenyon 1928, 140,146). The following quote relates to a family-owned fishing weir on a river to the east of Darlots. The area was being visited for the first time in 1841 by the Government Aboriginal Protector, George Augustus Robinson, who was collecting information on the remaining local Aboriginal groups. He wrote:

> "At the request of the natives, I visited Pat-woor-deet, a favourite fishing resort at the rapids (Moyne River). Several stages and weirs for taking fish had been erected… My native attendants pointed out an extensive weir, two hundred feet long and five feet high. They said it was the property of a family, and emphatically remarked 'that white men had stolen it and their country'" (Robinson, April 29th 1841, quoted in Kenyon 1928, 147).

This quote supports contemporary Gunditjmara claims that specific traps were used by different families. Following the end of the Mission era families once again relied on the trapping and selling of eels and other fish to support family income. This practice continued through to the mid-1960s (personal communication, Theo and Keith Saunders, June 1992). Different families still have use of their own known water holes in the Darlots River (personal communication, Steven Saunders, March 2003). Among generalized hunter/gatherers, the unpredictability and low density of food resources render ownership disadvantageous. Under richer resource conditions, there should be few disadvantages to recognizing claims by some of the more ambitious community members to own resources that they have developed on their own, such as ownership of fish that were procured with a weir that was built by individuals or individual families (Hayden 1996b, 51–2).

The emergence of powerful chiefs is theoretically a logical consequence of their other socioeconomic developments (Earle 1997). It is documented below that local chiefs in Southwest Victoria organised between them the great gatherings where trade and social exchanges took place (Dawson 1981, 72–3). Specialisation and redistributive exchange would confer substantial benefits. They would enhance productivity, diversify subsistence, and provide insurance against food failures in one sector or another. The prestige gained by the leader's effective management of specialisation and exchange would be a major support of his leadership (Brumfiel and Earle 1987, 2).

Ethnographic documentation exists of hereditary chiefs in Southwest Victoria, courtesy of James Dawson (1881), with supporting notes from Thomas and Sievwright, both Assistant Protectors of Aborigines in Victoria (Bride 1898, 398; Lourandos 1991). Protector of Aborigines Thomas (in Bride 1898, 398) has written:

> "Their government is patriarchal, the head of each family having control over his household… each tribe has a chief, who directs all its movements, and who, wherever he may be, knows well where all the members of the community are. About once in three months the whole tribe unite."

Mount Noorat, for instance, in Southwest Victoria, had always been an important and significant gathering place (Dawson 1881, 78–9). Periodically people were called together to attend meetings there for their cultural obligations; failure to do so meaning the forfeit of one's life (Wolski 2000). Of course, these movements of people were neither understood nor respected by the white invaders, and the visits themselves appear to have resulted in their deaths at the hands of the new landowners (Kiddle 1967, 122).

There is no doubt that the status of chief within western Victorian Aboriginal groups can be defined as elite when compared to the term as applied to other societies (Arnold 1996a, 1996b). Dawson (1881, 5–7, 27, vii) has recorded the following indicators:

1. Chiefs and their sons and daughters can only marry into the pool of an elite or nobility class, that is, the families of other chiefs.
2. There are separate terms for what has been translated as "chief" and "chiefess", and also for when addressing these people directly there are quite different words, again for both, and translated as "chief mine".
3. If a chief persists in marrying a commoner, his children by that marriage are not disinherited, but such marriages are highly disapproved of. The natives say that if chiefs were permitted to marry commoners, it would lead to endless quarrels and jealousies.
4. Chiefs alone can have as many wives as they wish – their presumably many children then being in this elite class. The sons of Chiefs can have two wives, while the commoners can only have one wife.
5. There is a "coming of age" ceremony for both males and females. When a chief's daughter comes of age, special activities take place including an evening *corrobboree* with her father leading the dance. The young woman is then eligible to own her own possum skin rug (Thomas in Bride 1898, 436).
6. Sievwright, on the 13th April 1842, recorded that for the occasion of a wedding, the hut belonging to the Chief of the bride's tribe "was well stored with provisions which were distributed amongst the party" (Sievwright in Gerritsen 2000, note 355). This act reflects a significant amount of affluence and generosity.
7. Matrimonial agreements and arrangements for all tribal members are made by the Chief.
8. Chiefs also expect to be recompensed by presents. Dawson has stated that these presents take the form of possum skin rugs, weapons, ornaments and food. Such an ornament includes a valuable spear called bundit that is made of a very rare heavy wood from the Cape Otway Ranges, and was no longer used as a functional item (Dawson 1881, 88).
9. Presents were also given for other services such as acting as referee in the settlement of disputes between contending chiefs and their respective tribes (Dawson 1881, 75).
10. Any two Chiefs have the power to send messengers to command attendance at the Great Meetings that are held periodically, at an appointed place and time, by agreement among the different tribes. People were expected to attend the meetings. The chiefs play a significant part in these meetings, making all decisions, political, social and economical, on behalf of their peoples (Dawson 1881, 72–3).

Dawson's reputation as a credible ethnographer has suffered adversely purely due to his stating that "Western District Aboriginal society was socially stratified along class lines and that overriding authority was in the hands of hereditary chieftains" (Lourandos 1984a, 218). Hiatt (1996) and others (Corris 1968 and Critchett [in Dawson 1881]) all repeat Curr's (1886) argument in declaring Dawson's perspective on chiefs to have been misled.

It is altogether too convenient to dismiss aspects of aboriginal culture that have failed to fit in the past, or continue to fit, with whatever anthropological theory is currently being argued (Wolfe 1999). It is possible that Curr, Corris, Critchett and many others before and since have been influenced by anthropological beliefs regarding the egalitarianism of the Australian Aborigine. Establishing the existence of hereditary chiefs in any precontact hunter-gatherer society provides a basis for arguing the opposite: for social stratification as the crux of cultural complexity (Arnold 1996a, 1996b; Hayden 1992).

Additional information to evaluate the situation comes through The Reverend J. H. Stähle of Lake Condah Mission on the Mount Eccles lava flow, who in 1880 wrote in response to a communication by Howitt:

> "The office of head man in the tribe was hereditary. When the head man died, he was succeeded by his son, or, failing a son, by the next male relative. This was the law of the tribe before any whites came into the country. The headman had the power of proclaiming war, and when he did this, all the men of the tribe were obliged to follow him. He settled all quarrels and disputes in the tribe. When he had heard both sides, and had given his decision in a matter, no one ever disputed it. In war all spoils were brought to him, who divided them among his men, after having reserved the best for himself. The men of the tribe were under an obligation to provide him with food, and to make all kinds of presents to him, such as kangaroo and opossum rugs, stone tomahawks, spears, flint nives, etc. (Stähle cited in Fison and Howitt 1991, 277).

This description of an all powerful-hereditary Headman of the Gunditjmara from the Mt. Eccles area, is one that could apply to a chief of any complex hunter-gatherer society. As Owens and Hayden (1997, 127) note:

> "cultures with highly complex socioeconomic systems were generally identified as the most densely populated societies in which leadership positions tended to be inherited by a close relative of the predecessor… Among these groups, socio-economic inequality was marked, with elites being addressed by special titles, receiving prerogatives and tribute, and often being exempt from common labour".

As a way to describe the workings of complex societies, analyses of hereditary inequality and states now focus on agency and power relations (Stein 1998, 5). Stein defines power as "the ability to pursue and attain goals through mastery of one's environment" and this can be exercised either collectively or individually by people over each other or their surroundings. Resources are the media through which power is exercised.

Dawson (1881, 69–72) claimed that all-powerful and elite hereditary chiefs governed in Southwest Victoria and between them organised the Great Meetings that had become such an integral part of the regional sociocultural and economic practice. Anthropologists, historians and archaeologists chose to disbelieve and even discredit Dawson for his claims. However, archaeological interpretations from the landscape analysis of the Mount Eccles lava flow lead to the conclusions that a socio-political position with powers as described by the Reverend J. H. Stähle of Lake Condah Mission is logical, rational and accurate. This description joins the archaeology to the ethnography, and we can now surmise that such a position existed to defend the facilities, the people and their property, and to facilitate the marketing of their particular speciality product, smoked shortfin eels. Lourandos (1987, 307) believes that the extensive networks and intergroup festivities, ceremonies and exchange that occurred between local societies helped to regulate the relationships between these high density competing groups. Such complex relations would require strong leaders.

The definition of the Headman, as described above, supports the claim that the Gunditjmara were a complex society (as initially proposed by Lourandos [1980b, 1983, 1985] and supported by Williams [1988]) in that they demonstrated mastery of their environment by harnessing the water which flows into and out of the area and the resource which relies upon it, the shortfin eel. It is posited that the specific environmental qualities that this region possessed, which the indigenous peoples used to their advantage, made possible the economic and social developments that occurred. This cause and effect argument is at odds with that of Lourandos who argues that the social dynamics that occurred in this region were not a product of the aboriginal-environment relationship. Lourandos' hypothesis advances that population increases and changes in social organisation were themselves the motivating factor behind environmental manipulation. However, Lourandos (1985) has also argued that the environment ceased to be a motivating factor in demographic and technological changes during the last 4000 years. The two hypotheses appear to be contradictory. Lourandos (1983) developed his "intensification" theory based on the social changes taking place from 4000 years ago. These include an increase in population, inter-group gatherings and exchange networks. These same social manifestations could also be interpreted as being a consequence of resource specialisation, management and surplus.

Summary

With the invasion of Gunditjmara territory by British land "squatters", the inevitable collision of cultures resulted in the destruction of indigenous societies and their socioeconomic systems. When the economically and spiritually significant landform created by the eruption of Mount Eccles, or Budj Bim, came under threat of alienation by the Europeans, the Gunditjmara defended it. The latter culture lost heavily in the conflict but not without giving notice that this was a valued and sacred place. Unfortunately, the physical nature of the lava flow kept ethnographers away. No systematic recording of cultural practices took place here. The draining of the wetlands and lakes has contributed to the "invisibility" of past land modification and resource use.

European socioeconomic systems subsequently all but destroyed the cultural memory of past Aboriginal settlement patterns. The loss of an Indigenous presence on the landscape means that the archaeologist's methodology is crucial. However, past surveys and excavations on the Mount Eccles lava flow (Coutts et al. 1978; Clarke 1991; van Waarden and Simmons 1992; Wesson 1981; Williams 1988) have failed to provide unequivocal archaeological evidence for its settlement by a socially complex fisher-gatherer-hunter society (Head 1990). This is despite hypotheses that there were such indigenous socioeconomies in the region (Lourandos 1980b, 1983, 1985, 1991; Williams 1988). By utilizing innovative but appropriate archaeological methods, the 2002 study presented here has produced evidence that supports the hypothesis that an Australian aboriginal society, the Gunditjmara, had established a sustainable economic settlement on the Mount Eccles lava flow by landscape modification and wetland and resource management (Builth 2002c). It reveals an environmental manipulation that reflects a highly organised community. Specialising in an industry of eel aquaculture and preservation, Gunditjmara society is reflected accurately in ethnographic descriptions that include despotic chiefs, large regional social gatherings, and extensive exchange systems; those social requirements which were considered by Lourandos (1991) as a necessary part of a socially complex society. Thus, new archaeological methods have finally provided data that support previous hypotheses that Southwest Victoria, at the time of initial European occupation, was home to socially complex societies.

Price and Brown (1985) provide an explanation for our failure to appreciate the nature of aboriginal socioeconomies in southern settled Australia:

> "A misplaced reliance upon ethnographically known groups has precluded an appreciation of the diversity of hunting-gathering adaptations. Foragers in more temperate and fertile areas of the world were replaced by farmers long before written documents recorded their way of life. Hunter-gatherers surviving to the ethnographic present do so in the most marginal areas of the planet... The absence of complex foragers in the ethnographic record makes suspect the analogical reasoning that dominates archaeological interpretation" (Price and Brown 1985, 3–4).

The focus in this research has been on the environment and ecology as providing the basic foundation upon which technology developed and the culture evolved. A cultural response in the form of technological initiative is a human trait. The eels and their physical requirements and traits provided the motivation and reward; the basalt blocks became building material, wood provided the structural frames for the weirs and dwellings, reeds were woven into traps, basketry and thatching for dwellings.

Some questions do remain, however. At what time in the past did the Gunditjmara take up the stones and construct the dams? How long after the channels had been constructed to bring the water and eels through to the sea did they dam the wetlands? How much time passed between initial landscape modification and the development of hereditary chiefs – or was it the other way around? How did the transition occur? Why and when? These questions are the subject of present and future research. Some answers are presently being sought by multi-proxy analyses of sediment cores from the swamps that have been identified as being culturally manipulated. Diatom analysis of the Mt. Eccles crater lake shows that 4000 years ago the climate became variable after the previous 7000 years of stability and high rainfall (personal communication, Dr. Aline Philibert, August 2003). Could this change to unreliable rainfall have triggered the cultural manipulation to ensure water remained in the wetlands? Could this climate variability have triggered cultural consequences that were eventually manifested in the social and political organization of Gunditjmara?

The main body of Condah swamp to the north has a basal (formation) date of 27,000 BP but it is not know if there was a direct link from this water body to the sea. A swamp further south on the Mt. Eccles lava flow associated with the aquaculture systems has a basal date of 14,000 years but shows abrupt ecological changes and disturbance occurring some time between 6,000 and 8,000 years ago. This change cannot be accounted for except for having been cultural in origin (personal correspondence concerning unpublished radiocarbon dates, Kershaw 2002). Eels could feasibly have been migrating up and down the Darlots Creek accessing these swamps for at least the last 7,000 years, since the sea level reached its present position. Further investigations are continuing into the chronology of the development of the aquaculture systems by multi-proxy analysis and dating of sediment cores.

Much research has yet to be done. Here, it is hypothesized based on the review of the evidence presented above that the sociopolitical scenario that existed at the time of European contact in Southwest Victoria – the development of which probably commenced roughly 4,000 years ago, as outlined by Lourandos (1983, 1985, 1991) – was a product of environmental manipulation and management that was a responses to climatic changes. It is now clear that Gunditjmara settlement on the Mount Eccles lava flow in Southwest Victoria, Australia was based on the management and control of the shortfin eel, *Anguilla australis*. This practice incorporated modification of the landscape and led to socioeconomic development analogous to complex fisher-gatherer-hunter societies elsewhere in the world. This statement is commensurate with the belief that a (fisher)-gatherer-hunter society's potential is contingent upon the local environment and the society's socioeconomic potential is conditioned by its technological capacity. The socioeconomic characteristics that the Gunditjmara appear to have developed have been recognised in other societies that inhabit perennial wetlands or exploit spawning or migrating fish species, and so allow a broader understanding of the nature of socioeconomic complexity worldwide.

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Heather Builth
School of Geography and Environmental Science
Monash University,
Vic 3800,
Australia
E-mail: Heather.Builth@arts.monash.edu.au

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 24–33

3. The Exploitation of Freshwater Fish during the Later Stone Age of Lesotho: Preliminary Results

Ina Plug

Exploitation of inland fish resources in the southern African Later Stone Age became significant from approximately 5000 BP, but fish remains are usually secondary in importance to the remains of other fauna. At Likoaeng, a site on the Senqu River, Lesotho, the focus was on fish. The altitude and cold, harsh winters of the area limit the species that were available. There are only five species suitable for exploitation: Labeobarbus aeneus, Labeobarbus kimberleyensis, Labeo capensis, Austroglanis sclateri *and* Clarias gariepinus. L. aeneus *is currently the dominant species in the river.* C. gariepinus *is also fairly common.* L. kimberleyensis*, a predator, is not common and* Austroglanis*, a rock catfish with specific habitat requirements, was probably never common.* Labeo capensis *is also fairly common, but is an alga- and mud-eater and therefore difficult to catch with line and hook. Adults of fairly similar size of this species dominate the Likoaeng samples. The results indicate that* L. capensis *were caught during their annual spawning run when they congregated. The river at Likoaeng has a large boulder and gravel fan where the Likoaeng River meets the Senqu. The limited numbers of* Labeobarbus aeneus *support this hypothesis; their remains suggest that this predator preyed on the congregating* Labeo *and were opportunistically caught by the fishers. Fishing techniques included spearing, as a few cranial elements were punctured.*

Introduction

The Later Stone Age in southern Africa commenced roughly 25,000 years ago. It can be distinguished from earlier Middle Stone Age period by marked changes in and expansion of artefact types and composition, new exploitation patterns, manufacture of a greater variety of ornaments, rock paintings, rock engravings, burials associated with elaborate rituals, and use of symbolism in rituals and social interactions. Works by Wadley (1986, 1987, 1992, 1995), Korsman (1990), Barham (1992) and others explore the dynamics of these Later Stone Age societies and draw analogies to the life styles and world view of the modern San hunter-gatherers of South Africa and Botswana as described by several authors (Bleek 1935, 1936; Bleek and Lloyd 1911; Lee 1985; Orpen 1974; Silberbauer 1981).

The Later Stone Age in southern Africa consists of a variety of contemporaneous lithic industries that changed over time. Mitchell (2002) provides a comprehensive overview of these industries, their relationships, and their spatial and temporal distributions. Regardless of the different lithic industries, the mode of existence for all was that of the hunter-gatherer. Differences in hunting strategies were mostly determined by the abundances of and the characteristic natures of the prey animals. Excavations in numerous rock shelters, cave sites and coastal middens show that these people were skilled hunters and were able to obtain a large variety of game species, including marine mammals such as seals (Fletemeyer 1977; Plug 1993a, 1997; Plug and Badenhorst 2001). From early on coastal Middle and Later Stone Age communities collected shellfish. Later Stone Age communities also fished using fish traps along the coast (Avery 1975) and fishhooks were also found in their shell midden deposits. They also made seasonal rounds to the west coast of South Africa to prey on the seal colonies that came and still come ashore in the summer months to give birth and raise their young. Communities living in the interior mainly relied on hunting and gathering of plants and small animals. It is only later from 5000 BP that river fishing in the interior became a recognisable activity (Hall 1990). Until the excavation of Likoaeng, the subject of this paper, all fish remains associated with LSA activities were retrieved from shelter and cave sites.

Open air sites relating to the Stone Age periods in the interior of southern Africa have little or no bone preservation due to the acidic nature of most of the soils and the generally short duration of occupation (Plug et al. 2003). It is only in coastal middens where large amounts of marine shell act as a buffer against soil acids that bone is well preserved. Likoaeng is the first identified inland open air site with excellent bone preservation comparable to the preservation found in sheltered sites of similar age. The samples therefore allow a clear glimpse of a stone age fishing community. The Likoaeng project included the following objectives:

- to investigate the possibility of seasonal occupation at the site;
- to determine fishing strategies;
- to investigate fish processing and the possibility of the preservation of the fishes caught;
- to estimate the Standard Lengths of the fishes identified using osteometric analysis of modern specimens;
- to investigate differential skeletal element preservation amongst the dominant species;
- to establish possible climate changes and the impact these had on the exploitation patterns at the site;
- establish osteomorphological and osteometric criteria for modern fish species that can be used to distinguish between the three dominant species identified from Likoaeng;
- to investigate the incidence, species and abundance of non-fish animal remains at the site (Plug et al. 2003);
- to determine relationships within the Later Stone Age communities and investigate the possibility that Likoaeng may have been an aggregation site (Plug et al. 2003).

The analysis of the Likoaeng material is ongoing and it is estimated that the analysis presented here includes only 50–55% of the recovered fish sample. Therefore the conclusions offered are preliminary. Only when the results of the full analysis are available will it be possible to address the above listed matters with full confidence.

Likoaeng

Likoaeng has been excavated by Mitchell (Mitchell and Charles 1996, 1998) as part of an extensive research programme in the Lesotho highlands (Mitchell 1988, 1993, 1996; Mitchell et al. 1994; Mitchell and Charles 2000). The site lies on the west bank of the upper Senqu River, close to the confluence with its tributary, the Likoaeng River, after which the site was named. It lies at 1730 m above sea level at 29º 44’ S latitude and 28º 45’ E longitude (Fig. 1). The excavated deposits are banked against a rock face and appear to have formed over a buried rockshelter that became sealed over time by aeolian sediments. The Senqu River becomes the Orange River in South Africa. This river is in the process of being renamed to the Gariep River, but as this name is not yet official both names are used in this paper.

Likoaeng has an uncomplicated stratigraphy. The state of preservation, the presence of many complete fish skeletal elements, and portions of articulated fish skeletons indicate that these were deposited within a short period and rapidly covered. The archaeological deposits are overlain and sealed by the nearly sterile silty sediments of Layers I and II, though Layer I is associated with a small ceramic Wilton assemblage and some bones of domestic animals of apparent recent origin. The poor quality of faunal preservation and the absence of discrete features in these upper layers, particularly Layer I, suggest that these deposits accumulated slower, or were covered more slowly than layers III, V, and VII-IX (single unit). Layers III, V, and VII-IX are rich in stone artefacts, bone and charcoal and are the main occupation horizons. They contain several shallow hearths and pits. Layers IV and VI are more sterile in content. It is probable that the cultural materials in these two layers are derived from Layers III, V, and VII/IX. An area of between 22 and 32 square metres was excavated. Below Layer IX a smaller area was excavated, between 3.6 and 6 square metres, spanning a total thickness of 1.5 m. These lower layers consist of fine-grained sands and ashy sandy silts, with the richest cultural assemblages in Layers XII-XVI. Bedrock was not reached and there is evidence that the deposit continues for at least another metre.

The site layers are nearly horizontal, but below Layer XI they slope increasingly down toward the river and show a marked increase in sandstone inclusions. It is possible that these sloping deposits are part of a talus of a buried rock shelter where the upper layers reflect continued use of the site as an open-air location after the shelter’s interior became inaccessible (Mitchell and Charles 1998). The site dates to the Late Holocene, as indicated by the associated post-Classic Wilton assemblages. Ceramics were present only in Layer I and consist of undecorated Later Stone Age pottery and included a decorated Early Iron Age sherd. The Likoaeng dates are derived from charcoal samples pretreated with acid and alkali. Calibrated ages were generated using the Pretoria

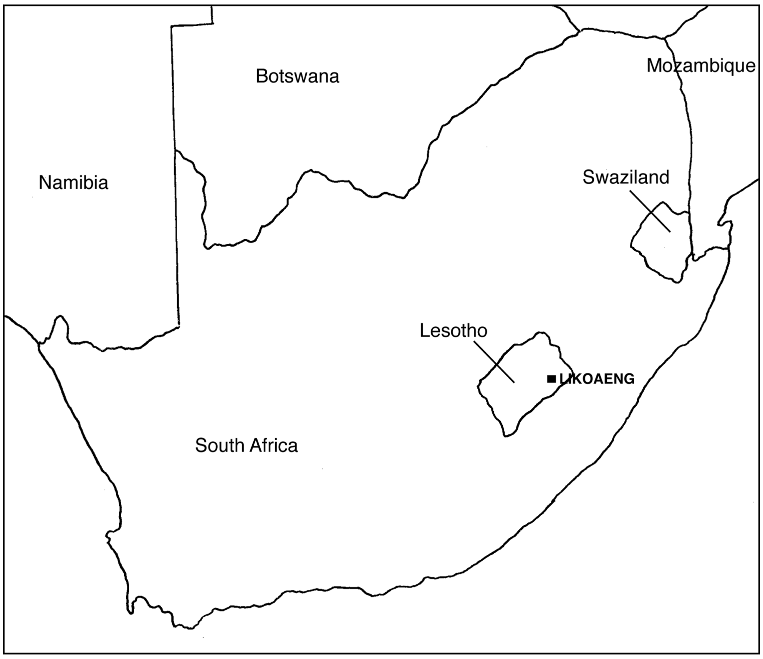

Fig. 1. The location of Likoaeng in southern Africa.

program for the southern hemisphere (Talma and Vogel 1993) and are presented as 1 sigma ranges with the most probable date(s) in brackets.

Pta-7877	1310 ± 80	AD670 (769) 874	Layer I
Pta-7865	1830 ± 15	AD235 (243) 250	Layer III
Pta-7097	1850 ± 15	AD221 (233) 252	Layer III
Pta-7092	1850 ± 40	AD159 (233) 252	Layer V
Pta-7098	2060 ± 45	52BC (6 BC) AD43	Layer VII
Pta-7101	2390 ± 60	413 (396) 379BC	Layer XI
Pta-7093	2650 ± 60	816 (799) 781BC	Layer XIII
GrA-13535	3110 ± 50	1400 (1362, 1314) 1266BC	Layer XVII

Notes on the Environment

The landlocked country of Lesotho is high lying, ranging between 1450 m and over 3000 m above sea level. Most of its southern, eastern and northern borders are formed by the edge of the high plateau that comprises a large portion of continental southern Africa. In Lesotho this plateau rises to its highest. As a result, vegetation consists of grasslands and African alpine vegetation, with only a limited number of tree and shrub species growing mainly in lower lying areas. The high mountains consist of basalts and lavas of the final phase of the Karoo sequence with thick wind and water deposited sandstone and shale sediments of the upper Karoo sequences immediately below the basalt.

Rainfall is usually limited to the summer months between September and April, but the onset of the rainy season varies and often there is little or no rain in September. Although it seldom rains in winter, there are occasional and sometimes heavy snows that fall as moist, very cold air moves from the south Atlantic against the escarpment. Frost is common in winter and summer temperatures seldom exceed 28° C. River water temperatures are cold, and this combined with the high altitude limits the number of fish species that can thrive there.

Fish Species of Lesotho: Habitat, Habit and Possible Occurrence in the Senqu at Likoaeng

Ambrose (1999) documents 17 fish species in Lesotho. Ten are thought to be local and indigenous, including four species of trout, four of carp, sunfish and bass. Seven species are exotic and were introduced during the 20th century. The status of two of the indigenous African species is questionable: Vlei tilapia, *Tilapia sparrmanii* [A. Smith 1840], is not native to Lesotho and was introduced during the 20th century, while the straightfin barbel, *Barbus paludinosus* [Peters, 1852], does not occur at present in Lesotho (Skelton 2001). The remaining eight species have been recorded in Lesotho Rivers in recent times. These fish species and their relevant habits are discussed below.

Family Cyprinidae: *Pseudobarbus quathlambae* [Barnard 1938], the tiny Maluti minnow with 130 mm standard length (SL), is currently endemic only in Lesotho where it is found exclusively in the upper reaches of the Senqu River. It used to occur in the Umkomazana River in KwaZulu-Natal, but became extinct there before 1940.

It prefers clear flowing water and river pools where it eats insects. It breeds in summer and eggs are laid in small crevasses between round boulders and other small stones. It could have occurred at Likoaeng and it is possible that some of the tiniest vertebrae found are either from this species, or from juvenile *Labeo/Labeobarbus*. However, as it is not a food species its inclusion in the Likoaeng deposits (if identified) would likely be incidental.

Family Cyprinidae: *Barbus anoplus* [Weber 1897], the chubbyheaded barb, is also a small fish, with males reaching 100 mm SL and females up to 120 mm SL. It is more common than the minnow, but is limited mostly to lower lying rivers in Lesotho and therefore unlikely to occur near Likoaeng at present. However, some as yet unrecognized changes in the environment and river conditions in the past could conceivable place this species closer to Likoaeng.

Family Cyprinidae: *Labeobarbus kimberleyensis* [Gilchrist and Thompson, 1913], the largemouth yellowfish, formerly *Barbus kimberleyensis* (Skelton 2001) is confined to the Orange (Gariep)-Vaal river system. It used to be common in the Caledon and lower reaches of the Senqu below 1500 m. Although probably not plentiful, it has been recorded in small numbers as high up as the Katse Dam (P. Skelton, personal communication 2003). Adults prefer flowing water in deep channels or under rapids. It is a prime predator eating insects and small molluscs when young but fish after it reaches 300 mm fork length (FL) or approximately 275 mm SL. It breeds from mid to late summer and spawns over gravel in flowing water. They grow slowly, reaching a FL of 100 mm only after two years and 300 mm FL at five years. Males reach breeding status at 6 years and females at 8. They are fairly long lived, reaching ages of 12 years or more. In South Africa a maximum of 825 mm FL has been recorded. This species is relatively easy to catch with line and hook. Relatively large specimens with a SL of 590 mm and 540 mm have been caught in the Gariep River in Augrabies National Park (Skelton and Cambray 1981). It is possible that this species could have occurred in the Senqu at Likoaeng, although at that high altitude they were probably not very common.

Family Cyprinidae: *Labeobarbus aeneus* [Burchell 1822], the smallmouth yellowfish, formerly *Barbus aeneus* (Skelton 2001) is a common native of the Orange (Gariep)-Vaal River system and can reach 500 mm FL (455 SL). It prefers clear running water in large rivers with sandy or rocky bottoms and is better adapted to higher altitudes than any other species in the Orange-Vaal river system (Nthimo 2000). This fish can be found at higher altitudes above sea level as well as in smaller subsidiaries than its larger cousin *L. kimberleyensis*. It breeds from spring to mid summer, typically after the first substantial rains of the season. They are known for their migrations upstream to spawn over suitable gravel bottoms, such as occur at Likoaeng. They are currently the most abundant indigenous species in the Senqu and its tributaries in Lesotho. Males become sexually mature at 200 mm SL and females at 240 mm SL. Larvae eat microscopic organisms, but adults are omnivorous. According to Skelton (2001, personal communication) adults often become avid mollusc feeders, concentrating on the bivalves of the genus *Corbicula*. The eating of these molluscs cause the pharyngeal teeth to become blunted as opposed to those of predacious *L. kimberleyensis* which remain sharp.

Family Cyprinidae: *Labeo umbratus* [A. Smith 1841], the moggel, occurs in most river systems in South Africa. In Lesotho it has been recorded in the Caledon River on the western border and in the lower Senqu, but not near Likoaeng (Nthimo 2000) where water conditions are probably too turbulent, as this fish prefers quiet backwaters (Merron and Tómasson 1984). There is some debate on their habitat preference, as Mitchell (1984) and Gaigher et al. (1975) maintain that the moggel will sometimes breed in fast flowing water and main channels, indicating greater adaptability than initially thought. However, it needs a hatching temperature between 20° C and 26.5° C (Mitchell 1984), which are higher temperatures than experienced in the upper Senqu, precluding this area of the river currently, but not necessarily in the past, as a breeding site. According to Skelton (2001) the moggel is known to hybridise with *Labeo capensis*. This implies that there may be few differences in the skeletal anatomy of these two species, possibly not enough to distinguish between them on fragmented and abraded archaeological material. However, in the case of *Labeobarbus kimberleyensis* and *Labeobarbus aeneus,* which are also known to hybridise under special conditions, there are some marked skeletal differences. The mouth of the moggel is adapted to its diet of soft mud organic debris and is placed at the end of the snout, but in rivers where *Labeo capensis* does not occur, the mouth is sometimes ventrally placed (Gaigher 1980). Moggels breed in summer after rains and migrate upstream to spawn in submerged grassy river banks and flooded areas, and in shallow rocky sections of a river. They may reach 500 mm total length (TL), estimated at approximately 430 mm (SL) and reach 100 mm by one year of life. They are sexually mature at 2 to 3 years of age at a SL of 150 mm for males and 250 mm for females. They can live 5 to 6 years.

Family Cyprinidae: *Labeo capensis* [A. Smith 1841], the Orange River mudfish, is native to the Orange (Gariep) River system where it is common and widespread (Gaigher 1976). It is one of the few species that have been recorded in the upper reaches of the Senqu near Likoaeng and prefers flowing water of large rivers. It feeds from rocks and firm plant surfaces. It can reach 500 mm TL (approximately 430 mm SL). The largest specimen collected in the lower and middle Orange (Gariep) River reached 430 mm SL (Skelton and Cambray 1981). During breeding time in summer, spawning fish congregate in large numbers in shallow rocky rapids where the eggs are laid. The river bed of the Senqu at Likoaeng is rocky and shallow and is potentially suitable for spawning. Juveniles can reach 80-90 mm SL within a year. Males become sexually mature at 220 mm SL and females at 240 mm SL. They can live up to nine years. It is currently the most abundant indigenous species in the rivers draining into the Katse Dam (Nthimo 2000), but is not as abundant in the higher regions of the Senqu. The Orange River mud fish is the numerically dominant species in the Caledon River on the western border of Lesotho, where they constituted 55 percent of the fish caught during a survey (Baird 1978). They are in best condition just before breeding when they have accumulated fat that will be used up during breeding. After breeding their physical condition is at its lowest. According to Fairall and Hamman (1977), fecundity is highest in the larger size groups.

Family Austroglanididae: *Austroglanis sclateri* [Boulenger 1901], the rock catfish, prefers subsidiaries of the Orange (Gariep)-Vaal River systems rather than the larger rivers and is therefore not common in the Senqu. It prefers strong flowing water, rapids and rocky habitats. Its diet consists of invertebrates such as insects, while larger individuals will also eat small fishes. Individuals can grow up to 300 mm SL. The current distribution of the rock catfish is uncertain due to conflicting reports and degradation of its environment. At present, its existence in Lesotho is threatened by pollution, dams, weirs and silt in the water due to erosion.

Family Clariidae: *Clarias gariepinus* [Burchell 1822], the sharptooth catfish or barbel, is one of the largest and most widespread of Africa's indigenous fishes. This species may have occurred in the Senqu River, but its past occurrence and distribution is uncertain. It tolerates most river habitats, but prefers slow flowing water and flood plains, can survive in poor, muddy water conditions and can travel overland provided conditions are moist. The Senqu River would have flowed fairly fast at times in the past, offering not a favourite habitat of this species. According to Skelton and Bills (2001, personal communication) if this fish did occur near Likoaeng it would have been in very limited numbers. The water is mostly too cold and the river too turbulent. It is omnivorous, a scavenger as well as a predator, and will eat any organic material, even sifting out plankton. Juvenile catfish need quiet waters, frequenting flooded areas and densely vegetated marginal pools (Bruton 1978), which are both absent near Likoaeng. Under suitable conditions it is fast growing and can reach a length of 200 mm SL in a year. Sexually maturity may be reached after one year, but two years is more common. Catfish can live up to eight years and reach their greatest size (up to 1.4 m) in rivers and dams where prey species are plentiful (Bruton 1976, 1978).

Methods Used

A comparative collection was compiled specifically for the project and consists of 14 specimens of *Labeobarbus aeneus*, four of *Labeobarbus kimberleyensis*, one possible hybrid of the two *Labeobarbus* spp. and five of *Labeo capensis*. These fish were cleaned by the author and designated for permanent storage in the Department of Archaeology of the University of Newcastle on Tyne, Newcastle, UK.

Identifications of the archaeological material were based on this collection and verified at the South African Institute of Aquatic Biodiversity (SAIAB), the former JLB Smith Institute for Ichthyology in Grahamstown, South Africa. Notice was also taken of other archaeozoological fish reports such as that of Von den Driesch (1986). Complete bones were measured with vernier calipers accurate to 0.1 mm, using some of the measurements proposed by Morales and Rosenlund (1979).

In listing the terminology of the fish skeletal elements the following sources were consulted: Lepiksaar (1983), Courtemanche and Legendre (1985), Heinrich (1985), Wheeler and Jones (1989), Rojo (1991), and Lyman (1994). The research material discussed in this paper comes from the 1995 excavations at the site. Material from the 1998 excavations has yet to be analysed.

Fish Bone Preservation

Many of the fish bones from the Likoaeng deposits are well preserved. Delicate bones such as those of the opercular series, the suspensorium and the neurocranium were often recovered as complete or nearly complete. The sturdier bones such as the palatine and the ceratohyale, particularly those of *Labeo capensis,* are seldom broken and should present a close estimate of the number of fishes present in the excavated deposits. The condition of the bones, notwithstanding their age, suggests brief deposition episodes with rapid covering of the deposits afterwards, as few bones show traces of weathering associated with long surface exposure. Full details of the body part preservation in general of these fishes and of the different species represented in the samples form the topic of another paper. Pectoral fin spines, sets of vertebrae, and some elements of the suspensorium and mandibular arch were occasionally found still articulated.

Fish Species Represented in the Deposits at Likoaeng

Fig. 2 presents the species and their abundances at Likoaeng. The sharp tooth catfish, rock catfish and minnow are excluded as only a few specimens of these (a few vertebrae, and eight skull fragments in all) were recovered. The figure shows clearly that *Labeo capensis*

Layer	*L. kimber.*		*Labeob. aeneus*		*Labeobarbus spp*		*Labeo capensis*		*Labeobarbus/Labeo*		Total NISP
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	Total
I	0	0	1	1	6	1	25	3	47	0	79
II	1	1	5	2	0	0	196	6	106	2	308
III	100	4	65	3	0	0	1469	83	2320	0	3954
IV	0	0	0	0	0	0	18	4	14	0	32
V	22	3	60	4	12	0	2689	178	3280	0	6063
VI	73	2	34	2	34	0	622	33	1284	0	2047
VII	264	12	77	6	212	1	5779	271	6939	0	13271
VIII	0	0	0	0	0	0	0	0	0	0	0
IX	0	0	0	0	0	0	0	0	0	0	0
X	0	0	0	0	0	0	7	1	10	1	17
XI	22	2	6	1	16	2	393	17	814	0	1251
XII	1	1	0	0	0	0	6	2	17	0	24
Total	**483**	**25**	**248**	**19**	**280**	**4**	**11204**	**598**	**14831**	**3**	**27046**

Fig. 2. The fish species from Likoaeng, NISP (Number of Identified Specimens) and MNI (Minimum Number of Individuals) per layer. L. kimber. = Labeobarbus kimberleyensis*;* Labeob. aeneus = Labeobarbus aeneus*. The rock catfish (*Austroglanis sclateri*) and minnow are not listed as the former is represented by three and the latter by one or two fragments only.*

is the most abundant species present. Of the 27,406 identified fragments, 14,831 could only be identified to cyprinids belonging to the genera *Labeobarbus* and/or *Labeo*. Of the remaining 12,575 specimens 11,204 are identified as *Labeo capensis*, 483 as *Labeobarbus kimberleyensis*, 248 as *Labeobarbus aeneus* and 280 as *Labeobarbus* spp. Minimum numbers of individuals (MNI) are included in this figure and are based on the most commonly represented element, with measurements of these elements taken into consideration.

In addition to the specimens identified to genus or species, the Likoaeng excavations yielded another approximately 500,000 fragmented specimens of neurocranium, skull, vertebra, rib intermuscular and spine elements.

Taphonomy and Pathology

A number of the bones are burnt and often calcined, indicating that they were exposed to high temperatures. There are no cut or chop marks visible on the fish bones. Some bones, seven in total (a few operculars, preopercles, a frontal and a few unidentified fragments from either the opercular series or hyomandibular arch), are pierced and display deliberately made round holes (Fig. 3). One fish rib had been broken but had healed during life with some misalignment.

Discussion and Conclusions

The Deposits of Likoaeng

The potential for rapid burial of the archaeological deposits as suggested by Mitchell and Charles (1996, 1998) was demonstrated in practice when a dust storm experienced during excavation deposited 15 mm of dust over the area in the course of a few hours (Hobart 2002, personal communication). A similar storm in the past may have rapidly covered objects on the surface at Likoaeng, and if so there appears to have been little disturbance after burial. There is no evidence of trampling or the severe fragmentation associated with animal remains in many of the shelter sites where occupation was more intensive and probably for longer periods at a time.

Species Expected and Species Found

As mentioned above, surveys of fish populations in the rivers of Lesotho indicate that *Labeobarbus aeneus* is the species most abundant at present (Nthimo 2000). However, although present, the remains of this species are not dominant in the upper 12 layers of Likoaeng. The species overwhelmingly represented in these layers is *Labeo capensis*. *Labeobarbus aeneus* and *Labeobarbus kimberleyensis* are represented, but in relatively low numbers (Fig. 2). *Austroglanis sclateri* is represented by a few fragments only. There are also some tiny vertebrae, either from minnows or, perhaps more likely, of very juvenile mudfish or yellow fish.

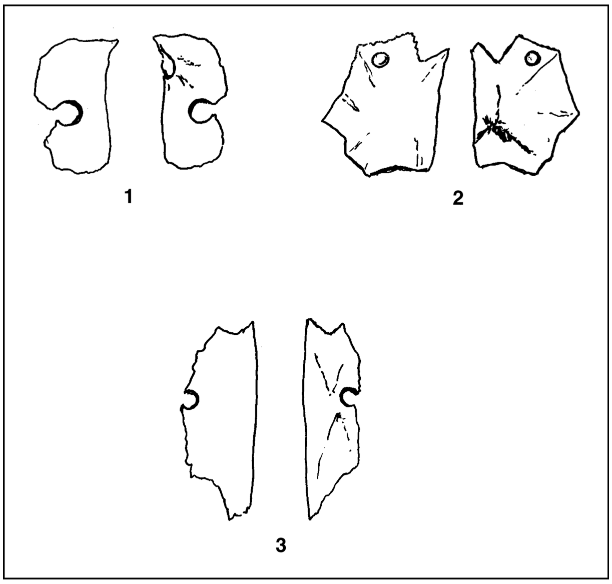

Fig. 3. Examples of perforated fish skull elements from Likoaeng. 1. Lateral and medial view of a Labeo capensis *operculum from Layer III. 2. Dorsal and ventral view of a* Labeo capensis *frontal from Layer XIII. 3. Dorsal and ventral view of a fragment of a frontal bone of* Labeobarbus kimberleyensis.

There is a change in Layer 13 where *Labeobarbus aeneus* suddenly becomes more prominent. It seems as if there are at least as many, or possibly more individuals of *Labeobarbus aeneus* than of *Labeo capensis*. The analysis of this layer and the layers below it are not yet completed and the results presented here are preliminary only. It is possible that the greater numbers of the smallmouth yellowfish indicate a human occupation of Likoaeng in spring, as this species tends to breed at that time.

Labeobarbus kimberleyensis is not a common species in the upper Senqu, nevertheless they have been identified at Likoaeng. It is possible that this fish, as a primary predator, would have eaten the eggs and hatchlings of *Labeo capensis*. In addition the congregation of the largemouth yellowfish, albeit in small numbers, indicates selective concentration. This suggests that the yellowfish used the same spawning grounds at generally the same time as the mudfish, as both species tend to breed during elevated levels of the river in early to mid summer. This means that both species would have been available to the fishers at Likoaeng.

Ageing and Breeding Status

Measurements of the bones and estimations of the Standard Lengths of the archaeological fish show that almost all individuals of all species were of prime breeding age when caught. Details of this analysis and the results are the subject of papers in preparation.

Natural or Cultural Assemblage?

Fish bone deposits are not necessarily of human origin; they can accumulate naturally and thus it is important that the agent(s) of accumulation be recognized (Butler 1993; Stewart and Gifford-Gonzalez 1994; Van Neer and Morales Muniz 1992; Zohar et al. 2001). The Likoaeng fish samples were without doubt accumulated by human action. Although it is possible that the site may have been flooded on occasion, the morphology of the site is such that flooding is most unlikely to have formed pools where fish were trapped and died when waters receded.

The fish-rich deposits contain Later Stone Age artefacts, hearths and the remains of a variety of mammals, birds and reptiles, almost all obtained through hunting and gathering (Plug et al. in press). The presence of burnt bone in association with hearths in the deposits of Likoaeng also suggests that at least some of the fishes were cooked and consumed on site. Butchering marks on some of the mammalian bones also supports human occupation of the site.

If small to medium size fishes were dried at this location, they would likely have been dried along with their bones, as is the primary method of fish preservation in many parts of Africa today. Fish are cut open, gutted and dried spitted below the head (Blache et al. 1962). Dried fish are seldom consumed on the catch and/or preparation site and would therefore not leave many bones. If the Likoaeng fish were spitted and dried, fewer skeletal elements would be expected. However, since almost nothing is known of fish processing and preservation methods during the southern African Later Stone Age, the method of preservation is a matter of conjecture. Filleting of fish is another possibility for fish preparation. However, the presence of intermuscular bones (a series of elements present in the genera *Labeobarbus* and *Labeo*) in the deposits, argues against filleting, as these bones are embedded in the muscles and would remain in the filleted portions.

Some Later Stone Age sites on the South African side of the Caledon River have also yielded some fish remains (Plug 2000a, 2000b), but these remains are few and not well preserved. Rose Cottage, in the same area, has a larger fish sample in the upper levels, but these have not yet been analysed. All three of these sites are sheltered sites well above and some distance away from the river, and the fish assemblages are without any doubt of human origin. At present the Likoaeng sample is the largest sample of an inland archaeological site yet described.

Obtaining Fish at Likoaeng

Amongst the artefacts identified from Likoaeng are numerous bone points present in all layers, and a single bone fish hook from Layer XIII. The Later Stone Age hunter-gatherers of South Africa used a variety of fishing techniques. These include grasping by hand, spearing from boats, spearing in shallow water, and using woven reed or grass baskets (Hobart and Smits 2002). Many of these techniques are illustrated in the rock art (Lee and Woodhouse 1970, 51–2; Pager 1972; Willcox 1963, 1984; Woodhouse 1979).

Bone fishhooks have been identified in many Later Stone Age deposits such as Mgede, Nkupe, Collingham and Maqonqo Shelters, all sites in the Thukela Basin in or near the Drakensberg. These sites post-date 4000 BP (Mazel 1986, 1988, 1996), suggesting that line fishing was commonly practiced. The round holes in the skull and cranium bones of some Likoaeng *Labeo capensis* specimens (Fig. 3) are consistent with the use of bone spear points or hardened wooden points. The presence of bone points at Likoaeng almost certainly indicates that spear fishing was at least one of the methods used to obtain fish. Considering the shallow boulder and pebble beds at Likoaeng where spawning likely took place, it is probable that many of the fish were also caught by hand and scooped out of the water in that manner. The presence of at least one bone hook suggests that some line fishing occurred, which could have been successful for capturing yellowfish.

Seasonal Activities at Likoaeng

The presence of so many fish of a single species that could not have been easily caught except during a short period of the year indicates that the occupation of the site was limited to that time of year when the fish were plentiful and easily caught. The model that best fits the available data is that the fish were caught during periods of spawning when they aggregated in large numbers. As described earlier, the spawning requirements of both *Labeo capensis* and *Labeobarbus aeneus* include shallow water with a rocky bottom. At Likoaeng these conditions exist, making the river in front of the site well suited to spawning fish.

It has also been shown that the species in question only spawn after the first heavy rains after which the river level is elevated. In Lesotho this can occur any time between September and December. The conclusion that can be drawn is that Likoaeng was occupied some time between early spring and early summer, and that the occupation coincided with the first significant rains. The predominance of *Labeo capensis* also indicates that it was this species in particular that came to spawn there, at least for the periods during which layers 1 through 12 were deposited, and that it was specifically targeted as a food source by humans. The smallmouth yellowfish tends to spawn earlier than the mudfish and the largemouth yellowfish, typically during spring.

The people who lived at Likoaeng must have been well aware of the habits of the fish and the association of their breeding strategies with the spring and summer rains and elevated river levels. Similarly, the Later Stone Age people exploited other seasonal available food sources elsewhere in southern Africa such as springbok and seals (Fletemeyer 1977; Plug 1993b, 1994, 1997, 1999). Exploitation of freshwater fish resources in Africa has often been seasonal and frequently associated with the rise and fall of river, lake and swamp levels. Rising levels are usually seasonal and often linked to fish breeding cycles. Seasonal exploitation has been documented for Late Palaeolithic sites from Wadi Kubbaniya in Upper Egypt (Van Neer 1986) and for modern people living along the north and east of Lake Chad (Inskeep 2001).

The people responsible for the upper twelve occupation layers at Likoaeng appeared to have lived on the site in mid summer, probably from late November to the end of December. In the older layers this occupation could have included the spring months as well. This pattern will be clarified once the material from later excavations have been studied. Plug et al. (2003) briefly examined the possibility that fishing at Likoaeng coincided with human aggregation events. The characteristic lithic and ornamental items usually associated with aggregation are not present, however, arguing against Likoaeng as having functioned as an aggregation site. However, the huge amount of fish present in the various occupation layers (estimates for Layer V alone indicate that a tonne of fish could have been processed) suggests that considerably more people were involved in the fishing activities than those usually present in a single band of hunter-gatherers. As there appears to be considerable variation in the signature(s) of aggregation sites (Mitchell 2002), the possibility that Likoaeng was in some way associated with aggregation activities cannot be ruled out.

Acknowledgments

I would like to thank the following persons for providing advice during the course of the project: Professor Paul Skelton, Dr. Wim van Neer, Dr. Peter Mitchell, Professor Geoff Bailey, Dr. Roger Bills and Nick James. I am grateful to the Leverhulme Trust for funding the project in general and the International Council of Archaeozoology, in particular the organisers of the 2002 conference in Durham, for providing financial assistance enabling me to attend the conference. Thanks are extended to Denise Wilson and staff of the University of Newcastle upon Tyne for the many arrangements provided locally.

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Ina Plug
Department of Anthropology and Archaeology,
UNISA
c/o P.O. Box 221022
Valhalla 0137
South Africa
E-mail: plugc@mweb.co.za

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 34–44

4. Mobility and Territoriality among Hunting-Farming-Trading Societies: The Case Study of Bear Hunting in Mountain Environments of Northeastern Japan

Kazunobu Ikeya

Ethnographic studies have shown that few hunter-gatherer societies anywhere in the world subsist solely through hunting and gathering. Most follow a complex subsistence strategy consisting of hunting, gathering, farming, fishing, herding, and trading. The Matagi and the Ainu of Japan combined bear hunting, salmon fishing, farming, and exchanges with Japanese traders. In this paper, relationships between mobility patterns, hunting, and territoriality among the Matagi of northeastern Japan are examined and clarified. A model for development of their territorial systems is proposed that posits a progression from an initial "common type" to either a "territorial" (or "nawabari") or "competitive" type. These two paths are discussed in relation to differences in the extent of human hunting pressure on natural resources and resource predictability.

Introduction

Socioeconomic organization during the prehistoric Jomon era (15,000–2500 BP) in Japan is typically described as semi-nomadic with combinations of hunting, gathering, and fishing subsistence. However, recent studies have emphasized that some Jomon groups were engaged in other activities, including farming and trading. These activities varied according to the local situation. Regional differences in lifeways are evident across three distinct environments: coastal, lake and lagoon, and mountain.

The Miomote River catchment basin in the Sea of Japan coastal region of northeastern Japan forms the region of investigation in this paper (Figs 1 and 2). Judging from the distribution of Jomon archaeological sites in this region, it is estimated that there were two major groups in the region, one relying primarily on flat land resources and the other drawing mostly upon mountain resources. However, it remains unclear how much interaction took place between these two groups and the extent to which they were territorial.

Evidence suggests that the settlement pattern of Jomon groups in the area included residential sites and hunting camps. Excavations at the Choja-Iwaya Rock Shelter Site (Fig. 2), a hunting camp along the Miomote River, produced a small quantity of Japanese black bear (*Selenarctos thibetanus japonicus* [Schlegel]) and Japanese monkey (*Macaca fuscata* [Blyth]) bones, freshwater mussel shell (*Cristaria plicata* [Leach]), as well as a large quantity of bones of Japanese serow (*Capricornis crispus* [Temmink])(Ono et al. 1993). The estimated age and season of death of the Japanese serow have been determined from cementum accretion lines on teeth of the lower jawbone. From examination of these lines it is estimated that the hunting season for Japanese serow was from late winter to early spring (Ono et al. 1993).

Zooarchaeological data alone provide only a limited view of animal resource procurement, territory management systems, and intergroup socioeconomic relationships. Using ethnological and ethnohistorical data, this paper aims to clarify how a group of recent people dependent on mountainous resources – the Matagi – hunted and managed bear resources within their territory. The study is based in the region surrounding the Choja-Iwaya Rock Shelter, and so, though recent in time, provides a setting similar to the prehistoric Jomon situation. It is thought that Jomon bear hunting took place in hibernation caves and by trapping. Here, I explore the contemporary state of hunting from the following

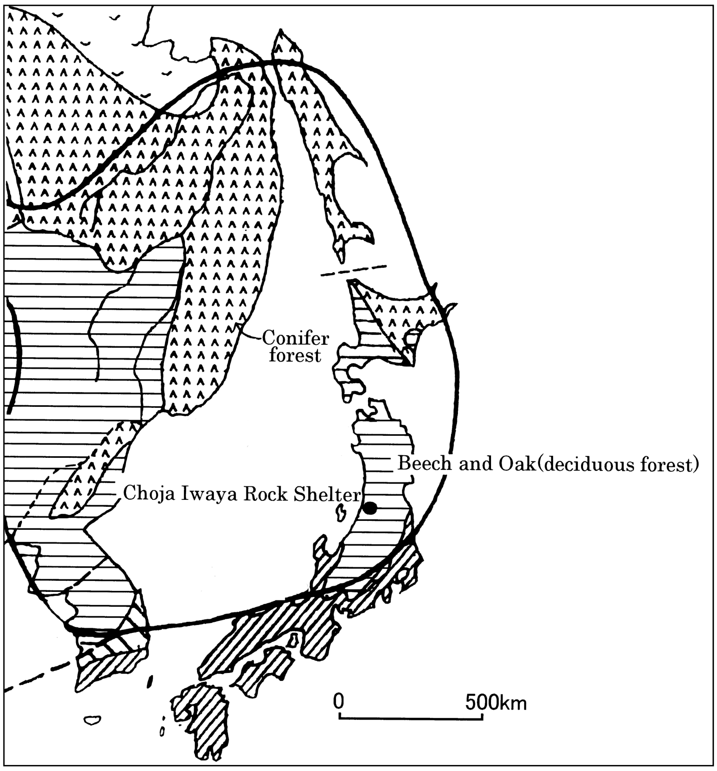


Fig. 1. Distribution of Beech-Oak deciduous forest in eastern Asia and location of Choja Iwaya Rock Shelter.

three vantage points: hunting techniques, utilization of resources, and allocation of resources. I also document differences in the extent of human pressures on natural resources with respect to territoriality patterns, and the degree to which the predictability of hunting success affects the nature of territoriality.

Animal Resources and Territoriality

A framework to Explain Territory Formation

Here, I propose a model that describes developments in the spatial organization of hunting systems. This model posits change along a continuum from a "common" type – essentially an undifferentiated hunting area used in common – through to more spatially structured approaches to organizing and managing hunting territories. The structured systems include what I refer to here as territorial (or "nawabari") and competitive systems, which are illustrated in Fig. 3 and explained in detail below. The common and territorial forms pertain primarily to semi-nomadic groups, while the competitive system develops primarily among societies involved in commercial economies. In the latter case, increasing product commercialization transforms the common type to the territorial ("nawabari") type and subsequently into the competitive type (Ikeya 1988: 116). The conditions that promote the adoption of these various systems can be expressed with the theoretical value K, where:

K = [the amount of resources * the predictability of resources] / [the number of hunters * demand for hunted resources]

The larger the K value, the more likely the common type of system will be maintained, where hunters pursue prey within a region unencumbered by formal territorial divisions of the hunting area. As hunted resources become extensively exchanged commodities, demands on hunted resources increase. Consequently, the K value becomes smaller and hunting takes place within increasingly socially defined patches (nawabari) within the previously undifferentiated hunting area. If hunting demands become extremely high, as is the case in commercial systems, the K value drops further, resulting in more competitive hunting and increased territoriality. Change in any of the variables can alter the value of K, and thus the theoretical relationships can be used to predict how changes in any variable will affect territoriality in a given situation. Below, I illustrate how this framework can be applied using ethnographic data pertaining to modern bear hunting practices in northeastern Japan.

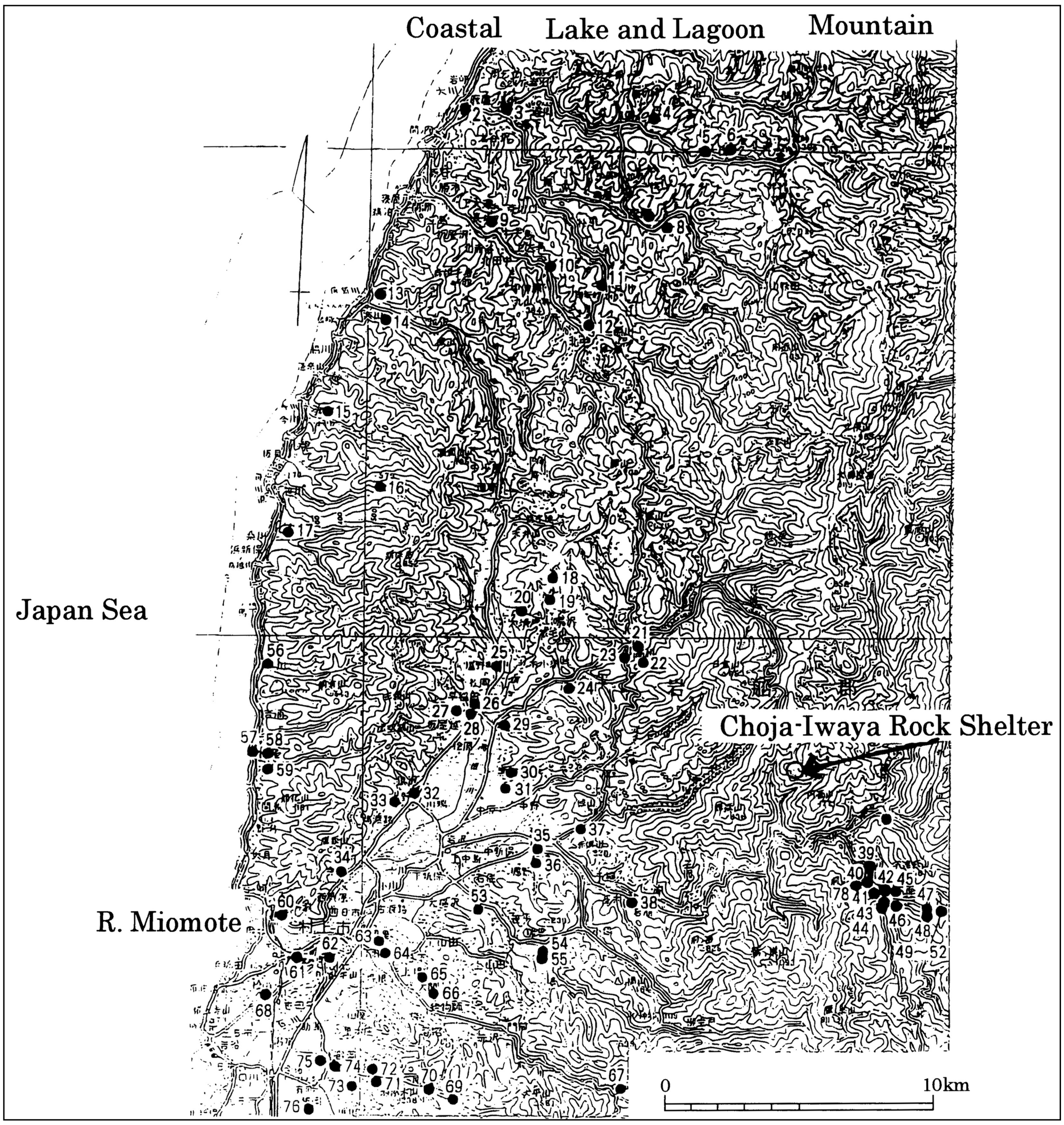
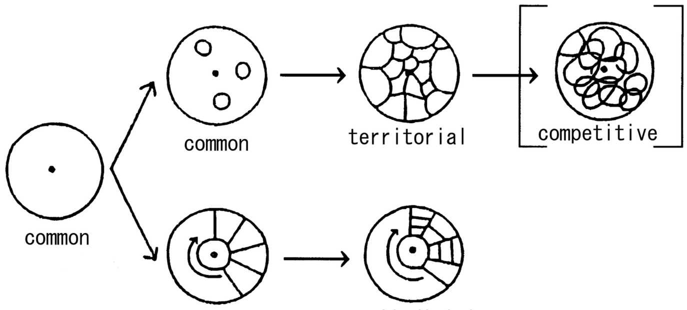


Fig. 2. Distribution of Jomon sites (black dots) in the Miomote River catchment basin.



K valued: *K= (the amount of resources × thepredictability of resources)*
/ (the number of hunters × demands for hunting).
(Ikeya, 1988 : 116)

Fig. 3. The development process of spatial structure in hunting territories (after Ikeya 1988, 116).

Overview of the Research Area

The Miomote River empties into the Japan Sea after originating in the Asahi mountain range, where peaks reach 1500 metres in height. Climate in the river basin area includes significant snow in winter, with accumulated snowfalls on river terraces ranging from one to three meters. In the vast flatlands a deciduous broadleaf forest of predominantly beech and oak occupies the land. Many medium and large sized mammals inhabit the area, including the Japanese black bear, Japanese serow, and monkey.

Archaeologically, three open-air sites and one cave site (Choja-Iwaya Rock Shelter) that date to the mid-Jomon period exist in the area. Many clay vessels were found in the three open-air sites. In the cave site, animal bones and charcoal were found. Later in the Jomon era, this cave continues to be used while two of the open-air sites were abandoned. The remaining open-air site is large, measuring 100 m from east to west and 70 m north to south. Here, stone lances, stone adzes, stone dishes, grinding stones, clay dolls, and chipped stone tools have been found. Given this evidence, it can be suggested that people aggregated into one primary community following the earlier use of three residential sites within a 2 km radius. Throughout this time, the Choja-Iwaya Rock Shelter is believed to have been a hunting camp remotely located from residential settlement. In mid-Jomon times, hunting focused on Japanese bear and serow, while later Jomon groups depended primarily on boar and deer.

Ethnography of Cave Bear Hunting and Management of Animal Resources

Hunting Techniques and Activities

In Japanese a one-year old bear is called a "wakame" while a two-year old bear is a "yarai". A three year old can bear young, and a young bear with its cubs is called a "kosugi". These distinctions are important, since the time when bears come out of caves differs according to their development stage. It is said that the bears typically come out around April 17. Small bears emerge earlier, followed by larger bears and, finally, late-born cubs with their parents.

The cave bear hunt must be carried out before the bears leave their caves. Mid March to early April is the best season for the hunt. At that time the accumulated snow pack hardens in the warmer spring temperatures, allowing the hunters to move around easily. Local villagers know of numerous bear caves distributed throughout the mountain range. For the hunt, the available hunters arrange themselves into groups and search the region in an organized fashion to economize on their labour. Meat from captured bears is distributed equally to all participants in the hunt.

Below, a typical April hunting day in a typical year is described. Three hunting groups were operating that day. One searched in the Mt. Engo area downstream on the Miomote River, a second covered the area around Mt. Maeyama south of their settlement, and the last operated in the Numanosawa region upstream along the river. The account provided here is of the second group.

At 6:30 a.m. I left the settlement for the hunting site with persons A and B, making a group of three. They carried guns and sacks made of Japanese serow skins. In the sacks were a knife ("kiriha") for dismembering the bear, rope, a flashlight, a lunch box, cotton work gloves, a box of matches, a two-way radio, and a raincoat. The wife of A provided beans used in a traditional Japanese Setsubun festival. It is believed that eating beans prevents injuries in the mountains.

Hunter A walked first, followed by B. We began climbing up the 700 m high Mt. Maeyama. The snow had not yet sufficiently hardened, so we wore "kanjiki" – special shoes for walking on snowy ground. On our way, we rested occasionally on the snow, making use of the Japanese serow skin leather.

We arrived at the top of the mountain at 8:35 a.m. From there, we could see the ridgeline of the Asahi mountain range and the entire mountainous region around the Miomote River. Passing the summit, we walked down to the other side. At 8:52 a.m., we arrived at the first bear cave (Fig. 4, cave 1). The local slope was so steep that we needed to support ourselves by holding on to tree branches as we moved. We immediately peered into the cave using flashlights, but no bear was observed in the cave. The hunters say that if there is a bear present, its eyes can be seen shining. Traditionally, people made a torch with pine branches to illuminate the cave. If the cave turned out to be empty, the hunters arranged branches in front of the cave opening. If found disturbed upon their return, this indicated that a bear had returned to the cave after the hunters had visited. However, hunter A noted that even without such indicators he can tell if a bear has returned from the smell and from the disturbance of foliage and branches around the cave.

We then visited cave 2 (Fig. 4), which was only a short distance from cave 1. Cave 2 is located at the edge of a cliff near a mountain ridge covered with Japanese white pine (*Pinus parviflora)*. It was larger than cave1, and into which hunter B could fit his whole body. In the back of the cave there was a larger chamber that could accommodate a few people. No bears were found in the cave.

We continued to caves 3 and 4, located on the other side of the slope in an area that was also covered with natural Japanese white pine forest. Cave 4 was about 10 metres deep and from 0.5 to 1 m high (Fig. 4). I went into the extreme rear of the cave and observed the situation within. The cave ceiling was rocky, but the floor was covered with soil and branches. According to B, the branches were brought by in bears. Bears hibernate in "usu" (nests) made of branches arranged into a

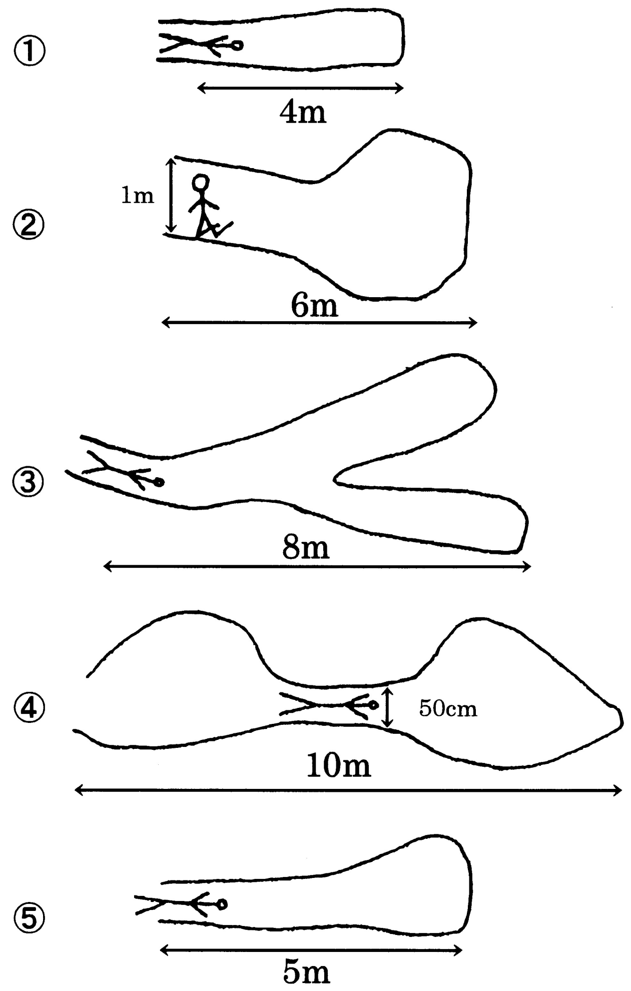


Fig. 4. Caves visited by the author during the hunting day trip described in the text (with human figures for approximate scale).

depression shaped like a low cut bowl. There was no bear in either cave 3 or 4.

We had lunch nearby at around 10:30 a.m. Hunter A seemed to be very tired, remarking "it is difficult to walk in mountains because this is my first time venturing out this spring season. I'm tired. I won't be able to join in collective hunting unless I get to practice tramping".

Starting to walk once again at 11:04 a.m., we reached cave 5 at 12:16 p.m. The cave entrance was narrow and could only be entered by crawling. The depth of the cave was around five meters. Roughly three meters from the entrance I found an "usu" made of fallen leaves and sand, but no bear.

Cave 6 (not illustrated in Fig. 4) was located roughly 10 minutes walk from cave 5. Hunter B warned me not to approach the cave because there was a thick snow ledge above it. He noted "it wouldn't surprise me if the snow ledge fell now. It's going to fall sooner or later." While the general timing and mechanism of such an avalanche (called "nade") can be explained with reference to physics and temperature, the hunters' intuitive ability to predict the exact timing of avalanches is uncanny. Hunter B quickly put his upper body into the cave only long enough to determine that there was no bear in it.

In the manner related above we visited and explored six caves, subsequently returning to the settlement without having located a bear on that day. On the return journey, we slid down snow-covered slopes using the leather. The two other hunting groups reported no signs of bears in any caves.

While no bears were encountered on this day, when they are found written and oral records outline the capture procedure as follows: when a hunter finds a bear in a cave he sets a smoky fire with green wood and directs the smoke into the cave; then he waits for the struggling bear to come out and pierces it with a lance or shoots it with a gun. In the past, brave hunters went into the cave directly to pierce the bear with a spear. Even in the flintlock era they used no guns but only lances. However, considering the form of hibernation caves as illustrated in Fig. 4, it must have been difficult in many circumstances for hunters to enter the cave to kill the bear. In most circumstances, waiting for the bear to come out of the cave would have been a less risky strategy.

The History of Known Bear Caves and Predictability of Cave Bear Hunting

Bear caves are found not only in the Miomote region, but also in the neighbouring mountainous areas of Asahimura-Iwakuzure and Yagiudo. Hunters personally took me to only six caves, but from personal interviews with other hunters 23 additional accounts of visits to potential bear denning locations were collected. Figure 5 shows the distribution of all caves, which include both rock caves and tree hollows.

The 29 caves can be divided into those that can be reached in a single day and those that require overnight trips. As described earlier, caves 1 to 6 required only a one-day trip. Caves 7 to 15 were also accessible in a single day. Caves 1 to 6 and 8 through 10 are distributed across adjacent mountains. The remaining caves, 16 through 29, are located upstream on the Saruta, Iwaimata and Suesawa Rivers (tributaries of the Miomote) and require an overnight stay to visit.

All 29 caves are named, and all are rocky caves excluding 24 and 29, which are holes in large trees. Local people call the rocky caves "ana" and the wooden holes "hitoki". Here, I briefly describe the history of visits and local situation for each cave.

Caves 1 and 2 are called "kedakura"; a 2.3 meter long bear was caught six or seven years ago in this cave following previous successful hunts there; it is known as a relatively dependable cave.

Caves 3 and 4 are called "yoshi-ana"; they were

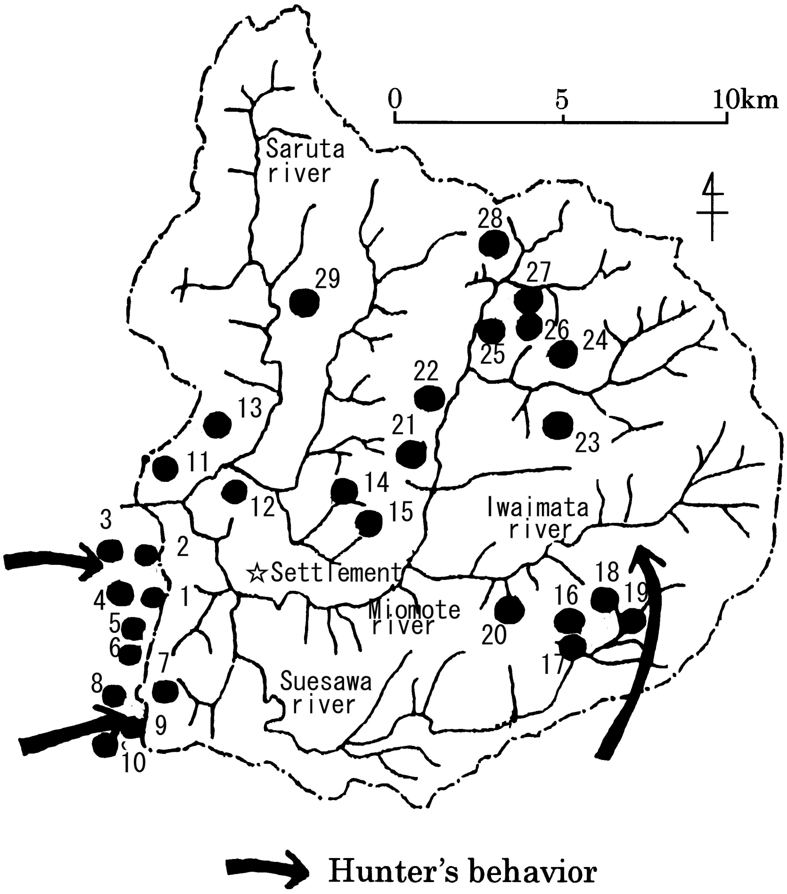


Fig. 5. The distribution of bear caves in the study area.

discovered recently by people in neighboring Iwakuzure, and were named after the discoverer ("Yoshi") who was "beaten" by a bear in the cave. When hunters visited the cave three years ago, this bear was not seen.

Cave 5 is called "amidakasa"; no bear has been observed in this cave.

Cave 6 is called "tomiyama"; no bear has been found here either. This is a relatively newly discovered cave, much like caves 3 and 4.

Cave 7 is "taka-ana", which has few accounts of bears having been observed here.

Caves 8 and 9 are known as "kurokura", with shallow walls; many bears have been found here previously. Yagiudo people have obtained two bears here in advance of Miomote people visiting the site.

Cave 10 is called "sasara"; bears were found here four or five years ago.

Cave 11 is named "engo" and has a long history. However, not many bears tend to den here, though one bear was found a couple of years ago. More than a decade ago, people from Chinawa (adjacent to Iwakuzure) caught bears in this cave.

Cave 12 is called "mizunokura"; it is said to be a good cave with a recent history of success, providing one bear each year over the last two years.

Cave 13 is "fukasawa", which is a small hole. I was told that in one year when hunters did not check the cave, a bear was found there and captured by non-local hunters.

Cave 14 is called "kumanokura" and 15 is named "komatsu". No detailed information is available for these caves.

Caves 16 and 17 are referred to as "tatehibia". One day, when people from Miomote were working around this cave, people from Oguni observed them from the other side of the ridge and remembered the cave's position.

Caves 18 and 19 are called "midashiana".

Cave 20 is called "shimoketagura". It is said that there are three other caves nearby, but we were unable to identify their location specfcially.

Cave 21 is "medashi" and 22 is "hiyogara".

Cave 23 is "danbuchi", having a small hole. Quite a lot of bears have been caught here before; recently a bear was found when hunters visited the cave seven or eight years ago. Above cave 23 was a wooden hollow tree (called

Name of trapper	Name of trap-hunt site	No. of bears caught	No. of traps
K. K.	Yuusawa	1	8
G. T.	Hiyogarasawa, Choushichisawa	1	5–6
Y	Kokuzouzawa, Yanagisawa	1–2	14–15
D	Komatukurasawa	1–2	7
T	Natakurasawa	1	12–13
Z	Ohido, Kohidosawa	0.7	5
S	Minakami, Ohidosawa	0.5	6

Fig. 6. Number of traps and bears caught by site for various hunters.

"ichiburi") that was also used by bears and visited by hunters. However, upon recent inspection by hunters it was determined that the tree had blown down and was no longer usable for denning.

Cave 24 is a wooden hole called "uwa-ana". There are holes amongst the roots of the huge tree, which offer a view inside the hollow.

Cave 25 is called "yokoyama"; apparently bears often stay in this cave.

Cave 26 is called "natagura-no-atarashii-ana" or a new hole of natagura. Cave 27 is "itagoya" and 28 is called "okake".

Cave 29 is a wooden hole called "totane-no-ana". When hunters were capturing a bear with a collective, open land hunting method called "tejishitori", the bear ran away into this cave, of which they had previously been unaware.

Three important points derive form these observations. First, bear caves consist mostly of rocky caverns and only a few wooden holes. Second, caves vary significantly in the degree to which they are used by bears, and it is rare that bears are encountered in the same cave every year. Overall, the probability of catching a bear over three years is 10 to 20% for caves in the area. Third, people from adjacent regions were allowed to enter Miomote territory for bear hunting on a "first-come, first-served" basis. Often, people from different areas were made aware of cave locations by observing Miomote people hunting. In some years, this resulted in people other than Miomote locals obtaining a bear from certain caves prior to Miomote hunting expeditions.

Trap-Hunt Activities and Management of Animal Resources

Technique and Hunting Activity

Hunting with traps is performed from late September to mid-November. It consists of an initial phase in which the hunters place traps ("osokiri") and a latter phase during which hunters recurrently check the traps ("osomi"). Below, I trace trap-hunting events based on interviews with elderly residents. Summary data for a number of hunters employing various numbers of traps are presented in Fig. 6.

Hunter "K. K." leaves in the early morning for a hunting site in Yuusawa along the banks of the Miomote River (Fig. 6), taking about four hours to reach the location. When he arrives, he places thin branches to form a path in an area along which bears typically walk. The width of this path is between 3 and 3.6 meters. He makes a ceiling for the trap with pine trees, since beech trees can decay after only a couple of years. Then, he fixes this hand-made ceiling to standing pickets with branches of canes and grapes at the height of his forearms, and then covers the structure with meshwork. In doing so, the suspended ceiling is placed low enough to prevent Japanese serows from being entrapped. Finally, stones are placed on the ceiling as a weight. The stones are collected from a nearby slope and weigh about as much each as the hunter can easily carry. The total weight of stone moved is said to be around 400 kg. I calculated the total weight of the stones used in one trap high on the Honkura mountain ridge in Yuusawa. The assemblage consisted of 11 large stones weighing 15 kg each, 28 mid-size stones of 8 kg each, and 21 smaller 5 kg stones, totalling about 500 kg. Since the hunters place traps in the same area every year, they can in fact recycle the stones and pine tree components. A pair of hunters spends approximately four hours in constructing the trap, and so can typically construct two per day.

Once construction is complete, subsequent hunter activity involves making trips to the trap to see if a bear has been captured. Such trips occur every 7 to 10 days. One trip does not necessarily involve visiting each trap. A hunter who walks to the northernmost area of the Kaminagate mountain ridge can see traps on the Honkura ridge on the opposite bank. If a bear has triggered the trap, then the area is visibly brighter with sunshine streaming into the forest. It is said in myth that the middle of the equinoctial week is a productive time for setting traps; many bears are mentioned as having been caught at this time.

When a bear is trapped, the hunter stabs its heart. He then separates the body parts with a "kiriha" or mountain knife. Then, he takes the skin off and removes its innards. When trapping a large bear too heavy for one hunter to carry, the hunter's father typically comes to the site and helps to carry the carcass. When no bear is found on trap-checking trips, the hunters sometimes collect maitake and nameko mushrooms and catch iwana mountain trout on their way home. In terms of success, there are years when no bears are trapped, though sometimes more than one bear can be trapped in one year. The average is estimated at around one bear per year. The "Oso" style type bear trap is usually successful once every year.

In the case of hunter "G. T." (Fig. 6), he had been trapping in Hiyogarasawa and Choushichisawa for four or five years until 1955 and had successfully caught five to six bears. His father set five to six traps and monitored them during an "Osomi" (trap-checking trip) seven to ten days later. They went together to the site to check for bears four to five times in one season. If a bear were trapped, they would stay overnight at the trap. There were years when they caught two bears at different times at the same site. One year produced no bears at all. All things considered, the average capture rate was again around one bear per year. Despite this seemingly regular average success, the hunting of bears with traps is a relatively unpredictable activity.

Spatial Structure of Trap Sites

Thus far, telemetry-tracking methods have not been implemented for Japanese black bears in Miomote, and information concerning bear movements and territorial behaviour are derived from direct observation. Square and circular observation fields have been set and records kept of footprints and spoor occurrences, and bear distributions and modes of life have been reasonably documented in the fashion (e.g., Maruyama 1975). According to the findings, bears are more likely to live in deciduous forests with beech and oak than in artificially planted and secondary forests. Faeces analysis reveals that their main foods are in fact the fruit skins of beech and oak. Bear faeces and footprints have been found in the same areas in multiple years, and on this basis it is assumed that bears do have certain areas that they inhabit regularly and repeatedly.

In order to investigate the relationship between bear and hunter strategies, I consider in detail the structure of three trapping sites, R and K on the left bank of the Miomote River, and J on the left bank of the Iwaimata River. Fig. 7 illustrates the local topographic features and vegetation in the vicinity of these trap sites based on aerial photos and data collected during fieldwork in August and October 1985. The trapping sites are distributed in areas with elevations between 200 and 1000 meters. Significant local features include a stream, a mountain ridge, and a steep slope connecting them. Beech forests, called "bunnou", cover the river terrace. In the case of site K, beech forests are found from Dorokujin to near the mountaintop to the southwest. Japanese white pines are scattered on the mountain ridge, and small grasses called "shibappira" grow on the steep slope connecting the bog and ridge. Such places where Japanese white pine is scattered across a narrow ridge and surrounded by a steep slope are called "kata".

Bear behaviour is largely influenced by this topography and vegetation. Hunters are fully aware of bear habits and set traps based on this knowledge. The case of sites K and J clarify the detail of trap-hunting site structure. At site K, Japanese white pine covers the ridges of "kaminagate" and "honkura" and traps are constructed in this area. However, no trap is placed on the nearby "shimonagate" ridge, where beech grows, despite the knowledge that bears wander around eating beech and oak nuts. Hunters have learned the bears' typical movements through observation, and it can be predicted that bears will walk along the path indicated by the arrow in Figure 7, and thus hunters have constructed five sites in "kaminagate" and three in "honkura". In the latter case, the trap is placed parallel to the mountain ridge, which is referred to as "tateoso-wo-kiru". Bears are trapped ("ochiru") either annually or every other year both in "kaminagate" and "honkura".

For site J, "tateoso" are put in five places and "yokooso" in one just location. A "yokooso" is a trap placed vertically with respect to the mountain ridge. Both "tateoso" and "yokooso" traps are used in combination according to the topography and vegetation of each site. Since bears have been caught in the area of Site J identified by the arrow in Fig. 7, it is assumed that bears often move toward the steep beech forest. It is relatively easy to predict bear travel routes because bears inhabit the area in fall on a long-term basis and their movements can be studied.

Hunting Territory

Data showing the distribution of hunting territory for individual households from the Taisho era (1912–1926) to early Showa era (1927–present) make it possible to explore the strategies used to manage hunting territories over time. During the Taisho era, there were on average 6 to 7 traps at each hunting site and 16 to 17 households engaged in trapping (Sakuma 1978). In total there were likely about 120 traps in the region. This estimate accords with the recollections of older hunters who reported about 200 sites with stone weights in the region.

Trap sites are distributed over the entire Miomote River basin, particularly along the Iwaimata River and upstream of the Miomote and Takenosawa (Fig. 8). Yet, there are

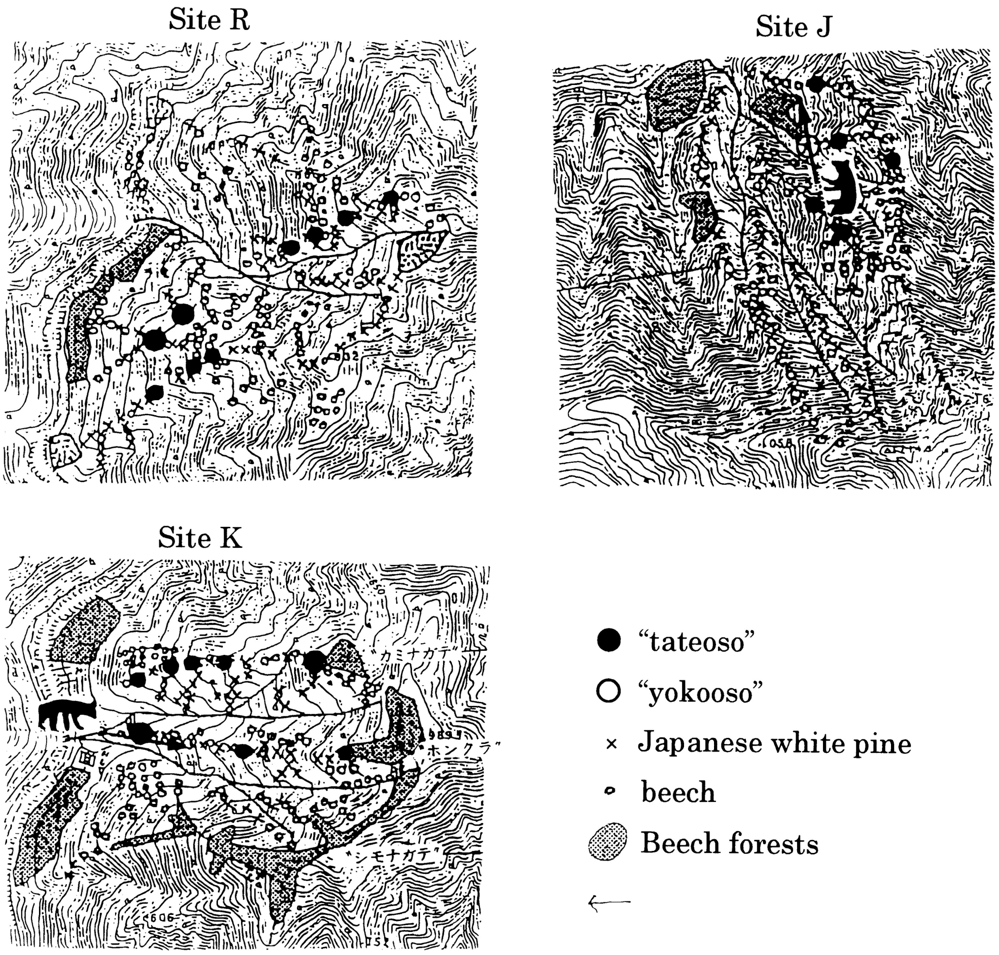


Fig. 7. Spatial structure of various trap-hunt sites.

many known trap sites that cannot be linked to specific hunters. This likely indicates that the trap-hunt method was used less frequently subsequent to the pre-Taisho period. For example, hunter K. I. changed trap-sites from Jippasawa in the higher reaches of the Saruta River to Fusubesawa because his grandfather became old and unable to go to the remote hunting site from their home. Thus, if fewer hunters were taking up the practice over time, a significant overall shift may have occurred in "owned' hunting locations to those trap sites closer to the settlement location of specific families.

It is also reported that an "unwritten rule" prohibits using the hunting sites of other families. When a branch family was established, hunting sites were re-allocated amongst the family members. Thus, over time trap-hunt site territories may have been increasingly consolidated as localized, exclusive-use family property. These processes and practices can be viewed as instrumental in promoting and consolidating hunting territories.

Territoriality as a Resource Management System

Up to this point I have considered methods for bear hunting and ways to allocate resources within and among hunting groups. In order to model the process of hunting territory formation and use more formally, I return to the theoretical relationships posited for relevant variables presented at the outset of this paper, whereby K, as a measure of the strength of conditions that promote territoriality, can be defined as:

K = [the amount of resources * the predictability of resources] / [the number of hunters * demands for hunted resources]

In calculating K values for various hunting methods, it is clear that if the number of hunters, the demands for hunted resources, and the amount of resources remain relatively constant, the predictability of the resource thus plays a significant role in determining the K value. In the cases related above, the regularity of capture (predictability) for Miomote hunters was one bear for each household in the case of trap-hunt, and one every 2-

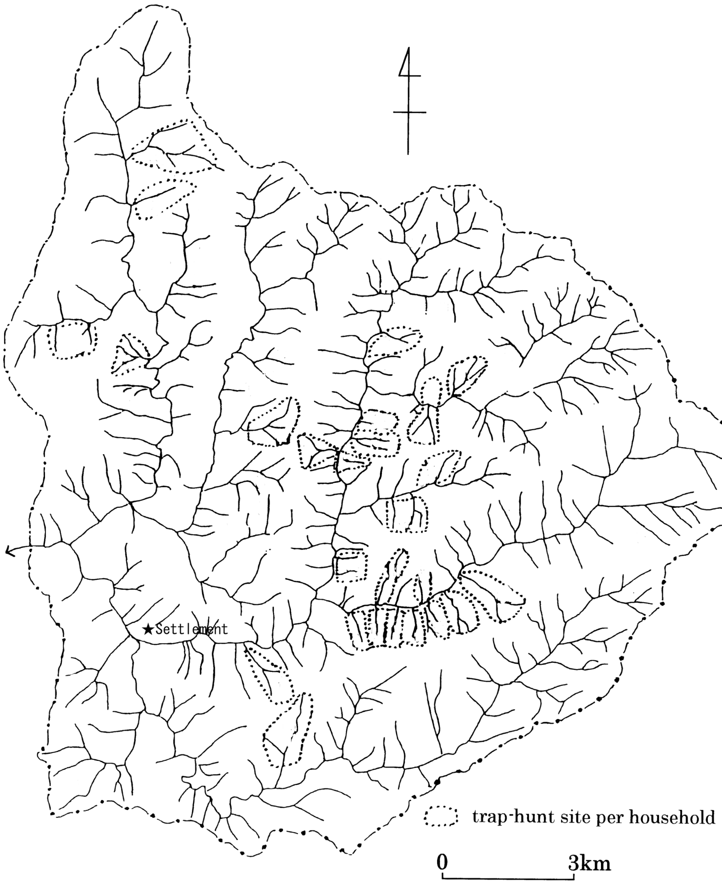


Fig. 8. Distribution of trap-hunt sites by household in the study area.

3 years in an entire settlement for the cave hunt. The trap hunt has a higher rate of success and thus can be considered more predictable.

When comparing the two methods with respect to the K formula, the greater predictability (and thus K value) of the trap-hunt allows us to predict that it should be accompanied by the "nawabari" (or territorial) hunting structure. In contrast, the K value for cave hunting is low because its predictability is low, and so this method is likely to correspond to the competitive type of hunting spatial structure. In this fashion theoretical K values for each type of hunting activity can be used to predict resource allocation methods and the territorial structure of hunting areas for bear hunting groups in the mountain areas of Japan. Such predictions may also prove useful for furthering our understanding of land use and land management strategies in the prehistoric Jomon period. In general, the relationship between variables summarized by the K value can be used to posit a process whereby territorial systems should shift from a "common" type to a "territorial ("nawabari") type as societies become more territorial and less mobile. This shift is marked by elevated human pressure on natural resources (see Uchiyama, this volume).

In conclusion, ethnohistorical studies have shown that few hunter-gatherer societies anywhere in the world subsist solely through hunting and gathering. Most follow a complex subsistence economy consisting of hunting, gathering, farming, fishing, herding, and trading. I believe that further comparative studies are needed that focus on the use and management of resources in hunter-gatherer societies where multiple subsistence modes are employed, such as with farming and trading. I have conducted fieldwork on the ecology and social history of complex subsistence economies of the Kalahari San (Bushman) in Botswana (Ikeya 1998, 1999). The San have combined hunting with dogs, equestrian hunting, and trapping with other subsistence activities, such as goat-raising, dry farming and trading furs with Kalagadi agro-pastoralists. In Japan, the Matagi combined bear hunting, gathering, salmon fishing, farming, and trading with Japanese traders. We need to be able to effectively model the relationship between mobility patterns, resource acquisition strategies, and territoriality within and between groups among a broader general class of hunting-farming-trading societies. With this study I hope I have clarified some of the basic relationships necessary to accomplish this.

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Kazunobu Ikeya
National Museum of Ethnology
10–1 Senri Expo Park, Suita,
Osaka 565–8511,
Japan
E-mail: ikeya@idc.minpaku.ac.jp

9th ICAZ Conference, Durham 2002
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5. The Significance of Freshwater Fisheries during the Jomon and Yayoi periods in Western Japan: An Analysis of Pharyngeal Tooth Remains of Cyprinid Fishes

Tsuneo Nakajima

This study is an examination of pharyngeal tooth remains from archaeological sites of the Jomon and Yayoi periods near Lake Biwa and Lake Mikata, western Japan. Pharyngeal teeth of extinct or locally extinct fishes were found at the Jomon sites, and analysis of teeth and head skeletal remains indicates that the freshwater fishery for crucian and common carps played an important role in subsistence in the Jomon period. The freshwater fishery for crucian carp continued through to the Yayoi period, when rice farming in irrigated paddy fields began. Paddy fields and their irrigation systems became utilized by the fishes of the littoral zone of Lake Biwa, and in effect became a mechanism for inducing them to spawn close to the Yayoi villages well removed from the shore of the lake. When a national governmental structure was first organized in the 7th century, cultivation of paddy fields began on the plains east of Lake Biwa on a large scale. Paddy fields have been maintained there ever since, and fish utilizing the artificial environment of the paddy fields and their irrigation systems have flourished. However, some relict fish lost their ecological niche as the paddy field fish expanded their range, as documented by the remains of extinct or locally extinct fish found in the Jomon sites.

Introduction

Abundant fish remains have been recovered from Jomon period archaeological sites in Japan. These fish remains provide important clues for reconstructing the environment and the manner of subsistence of Jomon people. Analyses of pharyngeal tooth remains of cyprinids have provided important archaeological and palaeontological data. Cyprinids, lacking teeth in the oral cavity, have a well-developed throat dentition on the pharyngeal bones. The presence of these pharyngeal teeth is one important diagnostic characteristic of cyprinids (Berg 1940). The external form, number, and arrangement of the pharyngeal teeth are important criteria for the classification of cyprinids. In this paper, the fundamental characteristics of the ancient freshwater fishery of western Japan are reconstructed based on the analysis of pharyngeal teeth deposited in archaeological sites of the Jomon and Yayoi periods. The state of the present fish distributions in the area surrounding Lake Biwa is discussed from an historical perspective.

Archaeological Sites

The archaeological sites from which pharyngeal tooth remains were analyzed include the Awazu shell midden, Akanoi Bay site, Torihama shell midden, and Shimonogo site (Fig. 1). The Awazu shell midden (Shiga Prefecture Board of Education and Shiga Institute of Cultural Heritage Protection 1997) and the Akanoi Bay site (Shiga Prefecture Board of Education and Shiga Institute of Cultural Heritage Protection 1998) are on the lake bottom of Lake Biwa and date to the middle and early Jomon period, respectively. The Torihama shell midden, a site of the early Jomon period, is on the shore of Lake Mikata close to the Sea of Japan (Research Group for Torihama Shell Midden 1987). The Shimonogo site near Lake Biwa was a middle Yayoi period village surrounded by several ditches (Kawabata 2001).

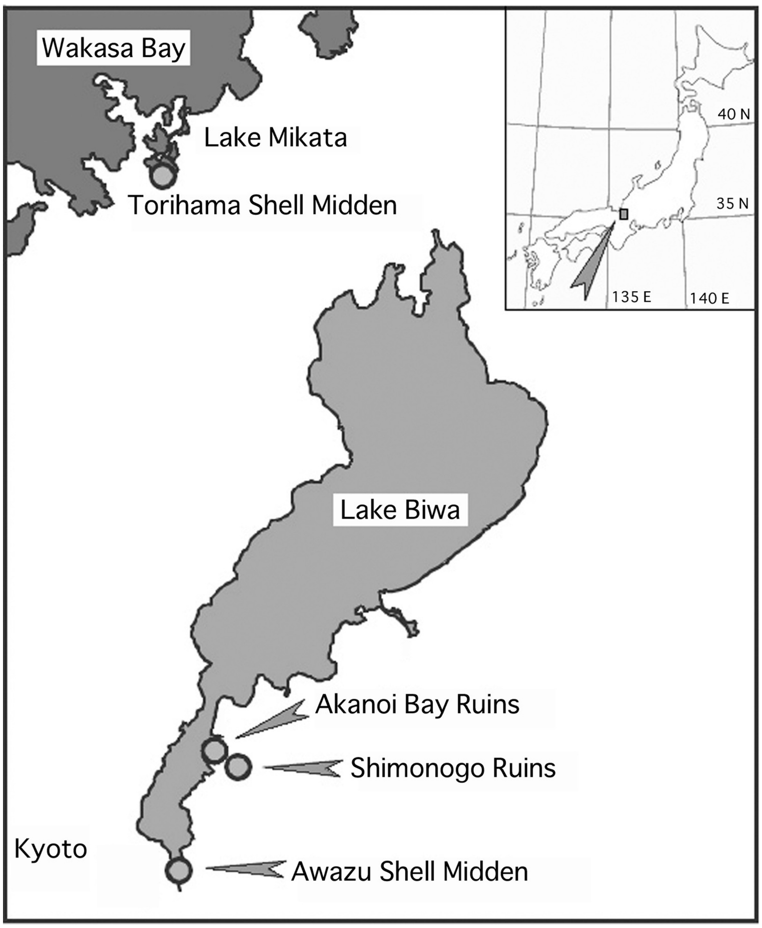

Fig. 1. Location of the four archeological sites from which pharyngeal tooth remains were analyzed.

Recovery and Analysis of Pharyngeal Teeth

The pharyngeal tooth remains from the archaeological sites were isolated and analyzed as follows (Fig. 2):

1. Mud containing pharyngeal teeth was washed with running water and passed through five sieves (mesh sizes: 3.35 mm, 2.00 mm, 1.00 mm, 0.50 mm, 0.25 mm).
2. The sieved materials were dried and the pharyngeal teeth were removed under a binocular microscope.
3. Photographs were taken of the isolated pharyngeal teeth with a scanning electron microscope (SEM: JEOL JSM-5800LV) and/or an optical microscope (Leica MZ Apo and Nikon digital still camera HC-300i). For observation using the SEM, the teeth were sputter-coated with 30 A of gold (JEOL Quick Auto Coater). SEM photographs were taken at an acceleration voltage of 15 KV.

Present Fish Distribution in the Area surrounding Lake Biwa

At present, introduced fishes (e.g., bluegill *Lepomis macrochirus* and largemouth bass *Micropterus salmoides*) are dominant in the littoral zone of Lake Biwa and populations of native fish are in a critical condition (Shiga Fishery Experiment Station 1996). In order to ascertain the distribution of fish species in the area surrounding Lake Biwa, I have been conducting surveys in conjunction with many local residents. Procedures and partial results have been reported in Nakajima et al. (2001). Native fishes such as *Zacco sieboldii*, *Zacco temmincki, Gnathopogon elongatus elongatus*, *Pseudogobio esocinus*, *Carassius auratus langsdorfii*, *Plecoglossus altivelis*, and *Rhinogobius* sp. were collected at many localities, confirming that they remain widely distributed. Introduced bluegill and largemouth bass were also found at many locations.

The distribution patterns of individual species are related to geomorphology (Fig. 3). The A-type pattern is represented by *Zacco platypus*, which is distributed in both delta and alluvial fan areas. The B-type pattern is

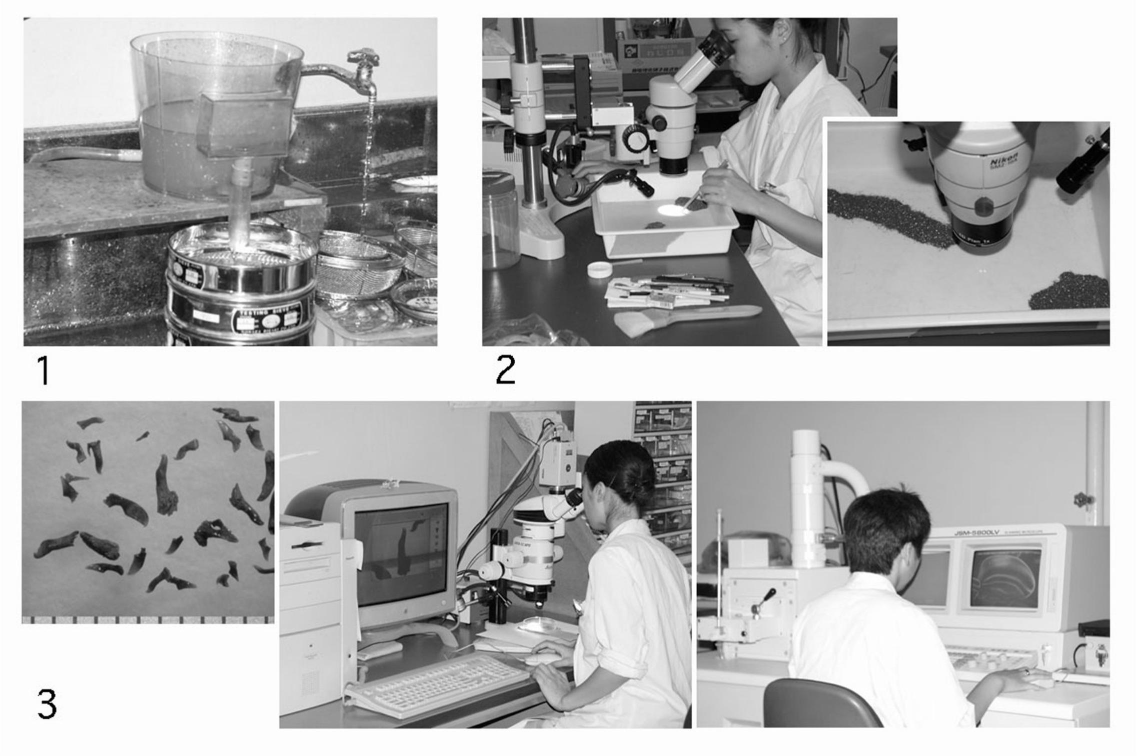

Fig. 2. Procedure of isolation and analysis of pharyngeal tooth remains: (1) washing with running water and passing through sieves; (2) collecting pharyngeal teeth from sieved and dried material; (3) photographing isolated pharyngeal teeth with an optical microscope and/or a scanning electron microscope.

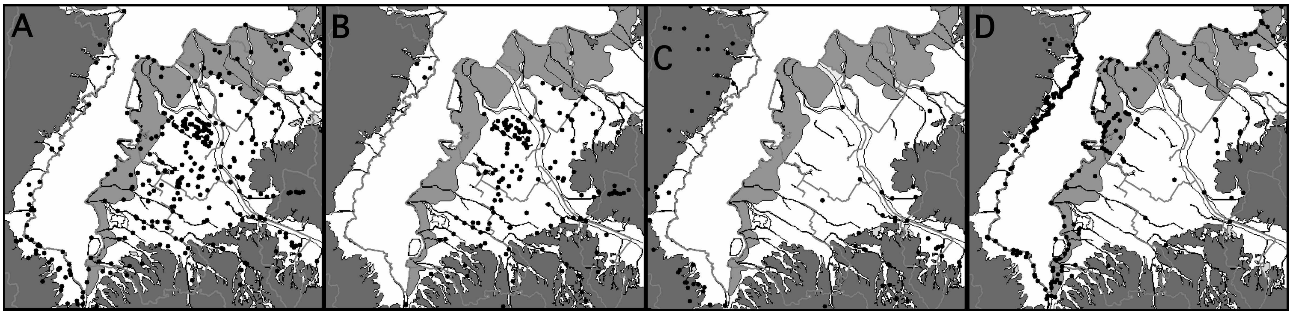

Fig. 3. Four generalized distribution patterns of representative species. Boundaries of delta area (light shading), alluvial fan area (unshaded), and hill and mountain area (dark shaded) correspond to distinct changes in slope: (A) A-type pattern of Zacco platypus*; (B) B-type pattern of* Zacco *sp.; (C) C-type pattern of* Zacco temmincki*; (D) D-type pattern of* Lepomis macrochirus *(from Nakajima et al. 2001).*

represented by *Zacco sieboldii* and *Gnathopogon elongatus elongatus*, which are distributed only in the alluvial fan area. The C-type pattern is represented by *Zacco temmincki*, which is distributed in hilly areas. The D-type pattern is represented by *Lepomis macrochirus* and *Micropterus salmoides*, which are restricted to the delta area. Native fishes exhibiting the B-type distribution pattern inhabit concrete-lined canals alongside paddy fields and in urban areas. We assume that these fishes were originally distributed in both the delta and alluvial fan areas but that they retreated from the delta area following the introduction of *Lepomis macrochirus* and *Micropterus salmoides* (Nakajima et al. 2001). This is not the sole explanation for their current distribution, however. I argue below that there are deeper historical reasons for this distribution related to local fishing and agricultural practices that existed prior to the establishment of a unified Japanese state.

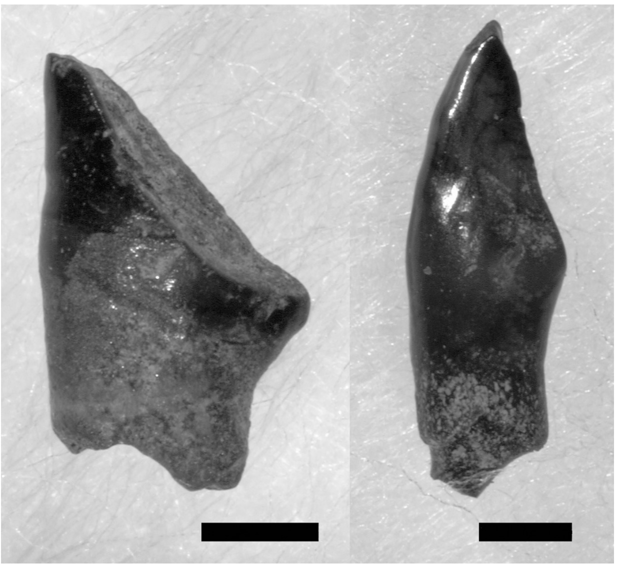

Fig. 4. Pharyngeal tooth remains of xenocypridine cyprinids, Xenocypris *sp. (right) and* Distoechodon *sp. (left), from the Awazu shell midden. Scale bars = 1 mm (from Nakajima et al. 1996).*

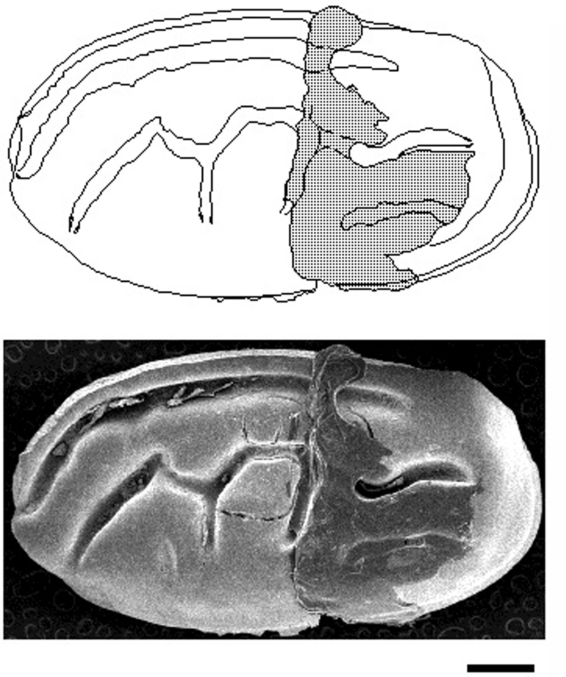

Fig. 5. Pharyngeal tooth remains of an extinct carp, Cyprinus *sp., from the Akanoi Bay ruins. Scale bar = 1 mm (from Nakajima et al. 1998).*

Extinctions of Fish in Lake Biwa

It is certain that many now-extinct fishes inhabited Lake Biwa over geological time. The Japanese freshwater fish fauna changed greatly in the middle Pleistocene some 400,000 years ago, when the present basin and environments of Lake Biwa were formed. At that time, many fish species became extinct in Japanese freshwater systems, including Lake Biwa (Nakajima 2001). Some fish species also went extinct in Lake Biwa more recently in the Holocene. Well-known examples of extinctions include two bitterings, *Rhodeus ocellatus smithi* and *Acheilognathus longipinis* (which also became extinct as a species), and a loach, *Botia curta*, which disappeared from Lake Biwa several decades ago (Shiga Prefecture 2000).

Our recent investigations of archaeological sites have shown that many now-extinct fish inhabited Lake Biwa during the Holocene. Remains of some xenocypridine cyprinids, *Xenocyprisis* sp. and *Distoechodon* sp., and cultrine cyprinids were found in the Awazu shell midden (Fig. 4)(Nakajima et al. 1996; Nakajima 1997). Xenocypridine and cultrine cyprinids now flourish in mainland China (Wu 1964) and were a dominant fish from the Miocene to Pleistocene in the Japanese archipelago (Nakajima and Yamasaki 1992). However, they are now absent in Japan except for *Ischikauia steenackeri*. The tooth remains from shell middens show that they existed in Japan until about 5000 years ago. An extinct carp, *Cyprinus* sp., was found in the Akanoi Bay site along with remains of the extant species *Cyprinus carpio* (Fig. 5) (Nakajima et al. 1998). It is apparent that several kinds of cyprinids became extinct during or after the Jomon period, and it is conceivable that this was result of the impact of human activities.

Fish Remains from the Awazu Shell Midden

Approximately 1% of the mud excavated from the Awazu shell midden by the Shiga Institute of Cultural Heritage Protection was processed with the water-sieve procedure described above. Approximately 1,000 pharyngeal teeth were isolated, about 700 of which could be identified (Fig. 6). Teeth of crucian carps, *Carassius* spp., were most abundant, followed by those of *Cyprinus carpio* and *Ischikauia steenackeri* (Nakajima 1997). These results show that the freshwater fishery played an important role in subsistence in the Jomon period. Most of these fish dwell in the littoral zone and offshore waters of Lake Biwa. It would have been difficult for Jomon people to capture these fish in the lake proper. However, cyprinid fishes including crucian carps come inshore for spawning periodically in an annual cycle, specifically during the rainy season. They were thus a reliable protein resource. Jomon people likely captured these fish during the spawning season.

Species	Number
Danioninae	
Zacco temmincki	4
Zacco platypus	5
Opsariichthys uncirostris	2
Cultrinae	
Cultrinae, gen. et sp. indet.	2
Ischikauia steenackeri	87
Leuciscinae	
Tribolodon hakonensis	20
Xenocypridinae	
Xenocypris sp.	1
Distoechodon sp.	4
Acheilognathinae	
Acheilognathus sp.	1
Gobioninae	
Hemibarbus barbus	20
Gnathopogon coerulescens	1
Cyprininae	
Cyprinus carpio	91
Carassius sp.	431

Fig. 6. Pharyngeal tooth remains from the Awazu shell midden (from Nakajima 1997).

Fish Remains from the Torihama Shell Midden

The Torihama shell midden is located on the shore of Lake Mikata and Paleolake Torihama northwest of Lake Biwa close to the Sea of Japan (Fig. 1). Although Jomon people dwelling at the Torihama site were able to get marine fish, they captured a great many freshwater fish as well, mainly crucian carp (Hongo 1989; Nakajima 2000). Analysis of the pharyngeal tooth remains from this site is still in progress, but a notable preliminary result is the presence of remains of *Opsariichthys uncirostris* and *Ischikauia steenackeri*. Although it is said that they are endemic to Lake Biwa (Mori and Miura 1990), their natural range included Lake Mikata in the Jomon period. Furthermore, teeth of a now-extinct xenocypridine cyprinid, *Distoechodon* sp. were also found.

The Torihama site was a seasonal settlement used in the spring and summer as a hunting camp. It is posited that the motivation for seasonal settlement only in spring and summer was the draw of the freshwater fishery focused on obtaining crucian carp spawning at the lakeshore (Uchiyama, this volume).

Processing of Preserved Fish at the Akanoi Bay Site

Hearths surrounded by stones and gutters with abundant fish remains were excavated at the Akanoi Bay site at Lake Biwa. Various fish and animal remains, including those of crucian carps, barbs, catfishes, wild boar, and deer, as well as the extinct carp *Distoechodon* sp., were found in the hearths (Uchiyama and Nakajima 1998). This set of features and remains likely relates to on site consumption around the hearths and tossing uneaten remains into a fire.

In contrast, only head bones – mainly opercula, pharyngeal bones, and teeth – of crucian carps and common carp were found in the gutters (Uchiyama and Nakajima 1998). The gutters appeared to have been workplaces where quantities of fish caught during the spawning season were processed and preserved as a food stock. The heads of the fish appear to have been cut off and discarded into the gutters while the body portions were processed for preservation. The precise mode of preservation (e.g., drying or smoking) is not clear from the archaeological evidence available. This preserved food stock assured year-round habitability of the lakeshore region.

Based on the archaeological remains, the preparation process can be reconstructed as follows (Fig. 7). First the isthmus between the gill chambers was cut in order to sever the branchial artery and drain the blood. Then the head was bent back to disarticulate its joint with the vertebral column. The gill arches including the pharyngeal arches and digestive organs were subsequently removed. The fish bodies were then preserved in some fashion, as mentioned above, likely by drying or smoking.

Jomon Culture in Western Japan

There are two types of Jomon culture recognized in prehistoric Japan. The Jomon culture in eastern Japan was based on a northern Asian Neolithic culture whose main protein resource was salmon and trout, and is consequently referred to as the "Jomon Culture of Salmon and Trout" (Yamanouchi 1989). Jomon culture in western Japan corresponds to Nakao's (1966) "Evergreen Forest Culture", which was distributed in the southern foothills of the Himalayas, Yunnan Province, China south of the Yangtse River, and western Japan (Ueyama 1991).

In western Japan there are many Jomon archaeological sites besides the Torihama and Awazu shell middens and

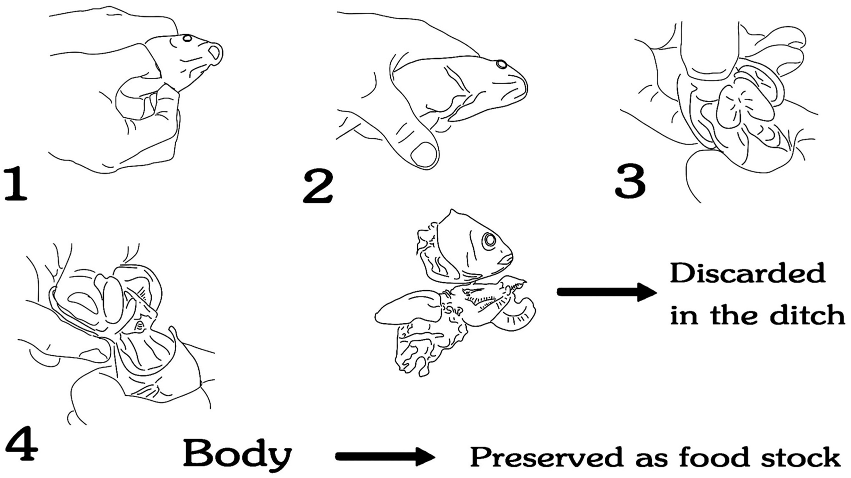

Fig. 7. Preparation process of crucian carp for consumption.

	Mud encasing cranial fragments	Mud from same horizon elsewhere
Pharyngeal teeth	102	2
Genus *Cyprinus*	1	0
Genus *Carassius*	101	2
Carassius cuvieri	48	1
Carassius auratus subsp.	11	0
Unidentified	42	1

Fig. 8. Fish remains from the innermost ditch in the Shimonogo site.

the Akanoi Bay site that contain pharyngeal tooth remains of crucian carps and common carp (Uchiyama 1998). The Jomon culture based on crucian carps and common carp diffused throughout the western part of the Japanese Archipelago, west of the Itoigawa-Shizuoka tectonic line, where the cyprinid fish fauna is more abundant than in eastern Japan (Nakajima and Miyamoto 2000). This Western Jomon Culture developed in marshland zones. Settlements faced lakes and lagoons, and the freshwater fishery was a key means of subsistence. Cyprinids including crucian carps were a reliable protein resource, and their preservation as food stock assured habitability of regions where they occurred. This culture has been called the "Jomon Culture of Crucian and Common Carps" (Uchiyama 1998).

Fish Remains in the Shimonogo Site

The Shimonogo site contains the remains of a Yayoi period village surrounded by several ditches. Diverse and abundant faunal remains including fish have been excavated from the innermost ditch, and blocks of mud rich in head skeletal fragments, mainly opercula, pharyngeal bones and teeth, have been found there, as in the Akanoi Bay site. Many pharyngeal teeth were isolated from the mud by the water-sieving method described above. These teeth are from the deep-bodied crucian carp, or "Gengoro-buna" (*Carassius cuvieri*).

Conversely, only a few fish remains, consisting of vertebrae, teeth, and skeletal fragments, were obtained from mud in the same horizon outside of the head part concentrations. Most elements were vertebrae (Fig. 8). These remains appear to have been burned, as they were discoloured white. It is assumed that people burned the fish and discarded them as garbage. In contrast, the blocks of head skeletal fragments of deep-bodied crucian carp appear to mark a workplace specifically devoted to processing fish for preservation.

Carassius cuvieri is endemic to Lake Biwa, dwelling in the offshore pelagic zone of the lake and coming inshore for spawning in the rainy season. The fish swim up small streams flowing into the lake and spawn in flooded areas. The Shimonogo site is located on the margin of the alluvial fan of the Yasu River. The site was well away from the shore of the extended lake in the rainy season. The people that inhabited Shimonogo village in the Yayoi period do not seem to have gone to the lakeshore to fish, perhaps because they were busy with rice farming during the spawning season of the crucian carp. Irrigated paddy fields are required for successful rice cultivation, and the irrigation canals and paddy fields may be assumed to have drawn the fish upstream from the lake to the village in their search for spawning sites. Paddy fields were thus not only sites for rice farming, but also for crucian carp fishing.

Adoption of Yayoi Culture in Western Japan

One of the characteristics of the “Evergreen Forest Culture” was slash-and-burn agriculture for rice cultivation (Fujiwara 1998). The Jomon people of western Japan extensively cultivated the tropical *japonica* race of rice without irrigation, in swamps at the waterside or in fields made arable by the slash-and-burn method (Sato 1992). The subsequent Yayoi period was characterized by rice farming in irrigated paddy fields. This technique and the temperate *japonica* race of rice were introduced to northern Kyushu from the Asian continent in the 3rd century BC.

The rapid spread of the Yayoi culture throughout the western Jomon cultural area is shown by the adoption of Yayoi pottery designs (Takahashi 1986). The rapid spread seems to have been facilitated by the fact that the western Jomon culture was based in part on obtaining crucian carps in marshland. We can assume that the primitive rice farming of the Jomon period largely involved planting of rice in areas flooded by rising water levels in the rainy season. These were also important areas for catching spawning crucian carps. In western Japan, the freshwater fishery was a key to subsistence, but was combined with this rice farming in marshes. The technique of rice farming in irrigated paddy fields and the temperate *japonica* race of rice were thus readily introduced there.

The freshwater fishery remained a key source of subsistence during the Yayoi period. Yayoi people captured many crucian carp spawning in the rainy season and processed them as food stock in the same manner as in the Jomon period. About 40% of the rice remains recovered from the Shimonogo site consisted of tropical *japonica*, which was the race of rice planted during the Jomon period (Sato 2000). This continuity suggests new cultural practices were easily adopted and adapted to preceding practice. In the Yayoi period, paddy fields were cultivated in lowlands along small rivers. These paddy fields and their irrigation systems were used by fish of the littoral zone of Lake Biwa, and in effect induced them to spawn close to the villages.

Explanation of Present Fish Distribution

Today, fish dwelling in Lake Biwa’s littoral zone are also widely distributed in the paddy field zone in the plains surrounding the lake, including alluvial fan areas. When a national governmental structure was first organized in the 7th century AD, cultivation of paddy fields began in these plains on a large-scale. Paddy fields have been maintained there ever since, and fish utilizing the artificial environment of the paddy fields and their irrigation systems flourished.

Fig. 9 shows the distribution of cultivation in the 7th century AD and the distribution of two fishes, *Gnathopogon elongatus elongatus* and *Zacco* sp., in Shiga prefecture. Their distributions overlap significantly. Most of the cyprinid fish species in Japan are known to inhabit irrigation systems of paddy fields. Some of them utilize the paddy fields for spawning and nursery sites (Saito 2000) and are known as “paddy field fish” (Yasumuro 2001). It appears that some relict fish lost their ecological niche as the paddy field fish expanded their range, as indicated by the remains of extinct or locally extinct fish found in Jomon sites.

Conclusion

Human beings initially depended on the natural resources of environments that evolved through long processes of natural history. Elements of their culture develop in response to these environments. Accordingly, a culture based on the freshwater fishery developed in western Japan where a rich freshwater fish fauna was available. Rice farming in paddy fields, which was introduced from the Asian continent to northern Kyushu in the beginning of the Yayoi period, rapidly spread through the western Jomon cultural area. Paddy fields have been cultured on a large scale since the 7th century, and most cyprinid fishes adapted easily to and flourished in the artificial environment provided by paddy fields and irrigation systems. A freshwater fishery based on paddy field fish was effectively combined with rice farming in paddy fields, and the resulting subsistence complex continued in marshland regions such as the shores of Lake Biwa up until modern times.

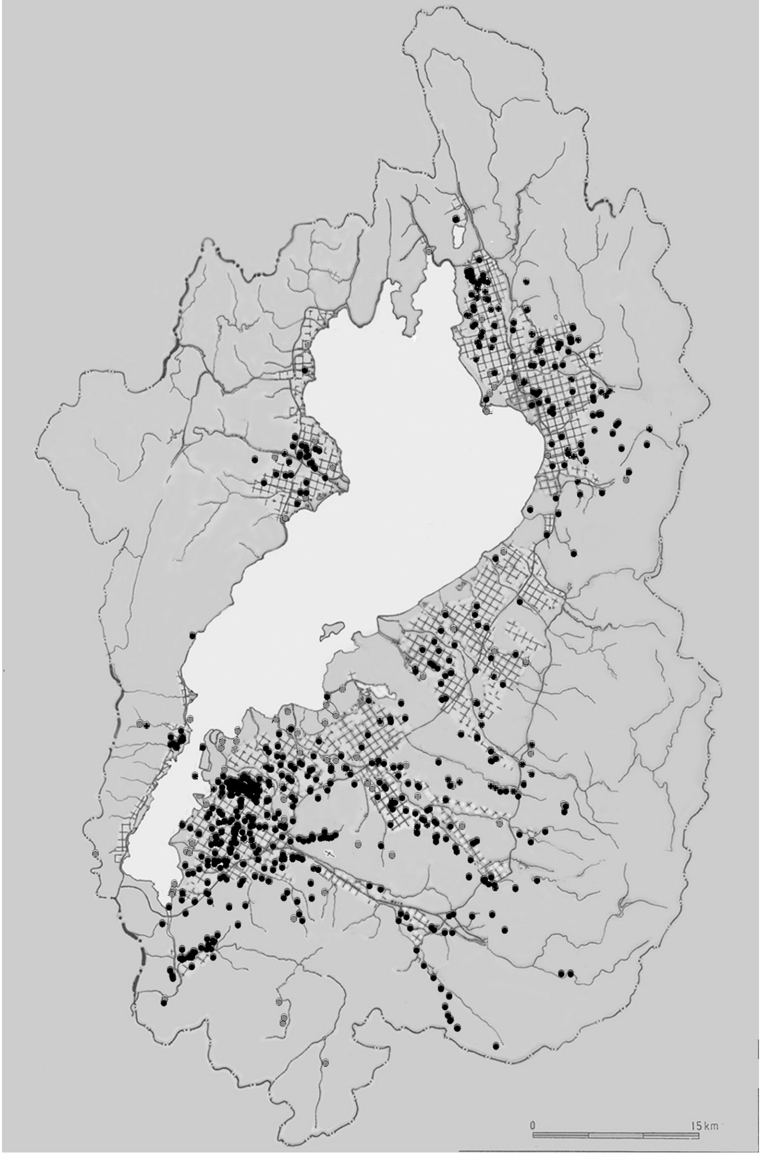

Fig. 9. Distribution of large-scale rice cultivation in the 8th century (cross-hatching) and the current distribution of two fishes, Gnathopogon elongatus elongatus *(light dots) and* Zacco *sp. (dark dots), in Shiga prefecture.*

Acknowledgments

I am grateful to many people who discussed this topic with me, especially Dr. J. Uchiyama (Research Institute for Humanity and Nature, Japan), Mr. I. Iba (Shiga Institute of Cultural Heritage Protection), and Mr. K. Kawabata (Centre of Cultural Heritage Protection, Moriyama City). I wish to express my thanks to Dr. M. J. Grygier (Lake Biwa Museum) for correcting the original English text.

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Tsuneo Nakajima
Lake Biwa Museum
1091 Oroshimo-cho
Kusatsu
Shiga 525–0001
Japan
E-mail: nakajima@lbm.go.jp

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 54–79

6. From Fisher-Hunter to Farmer: Changing Socioeconomy during the Chulmun Period in Southeastern Korea

June-Jeong Lee

This study examines socioeconomic changes during the Chulmun period (6000 to 1300 BC) in southeastern Korea. Analysis of faunal samples from shell middens in Pusan-Kimhae and Kosong-T'ongyong suggests that Chulmun people in both areas were successful fisher-hunters, exploiting both marine and terrestrial resources according to seasonal cycles. Due to environmental changes and/or population increase during the Middle Chulmun period, Chulmun groups experienced a certain degree of resource stress, with different adaptive strategies pursued in each area to mitigate this stress. Groups in the Pusan-Kimhae area quickly turned away from exploiting marine resources and shifted to heavier dependence on terrestrial resources during the Late Chulmun period. In the Kosong-T'ongyong area, the exploitation of marine resources was intensified by procuring more diverse species during the Middle and Late Chulmun periods. In the subsequent Mumun period, the exploitation of marine resources was suddenly reduced. One of the major factors that promoted the shift to a terrestrial-oriented strategy was the cultivation of domesticated plants.

Introduction

The Chulmun period in Korean prehistory, dated to 6000 to 1300 BC, is characterized by (1) a shift from gathering-fishing-hunting subsistence to an agricultural economy and (2) the rise of social complexity. Chulmun culture has been traditionally viewed as static, with the drastic change from simple hunting and gathering to farming with complex social structure having been stimulated by the migration of farmers from northern China at the end of the Chulmun period (e.g., Kim, W. Y. 1986). Recent analyses of palaeoethnobotanical data, however, indicate that several species of domesticated plants were exploited by Chulmun hunter-gatherers as early as the Middle Chulmun period (3500 to 2500 BC)(Ahn 1998; Ha 2001b). Along with the increasing use of domesticated plants, social complexity clearly increased during the Chulmun period. Chulmun social organisation was relatively simple in general (Nelson 1987). However, the Late Chulmun period (2500 to 1300 BC) shows evidence of increasing sociopolitical complexity in settlement patterns and burial practices. On this basis Chulmun societies have been defined as complex hunter-gatherers (Rhee and Choi 1992). This transition took place over a millennium, beginning in the Middle Chulmun period (e.g., Shin 1994, 1999; Yi 1991).

In order to understand the dynamic processes of Chulmun socioeconomy, this study documents the long-term changes in subsistence and some aspects of the changes in social structure. While Korean archaeology has fervently debated the topic of the transition from hunting and gathering to agriculture (e.g., Ahn 1998; Choe 1990; Nelson 1992, 1999; Norton 1996; Shin 1994), the actual changes in subsistence patterns have been poorly investigated. In order to delineate the processes of subsistence changes more accurately, this study investigates shell midden sites from two areas located on the southeastern coast of Korea: the Pusan-Kimhae area and the Kosong-T'ongyong area.

Analyses of the shell midden data are undertaken to document changes in (1) shell midden site patterns and (2) resource exploitation patterns. First, the spatial and functional organisation of shell middens and their temporal changes through the Chulmun period are considered. Second, shellfish exploitation patterns are elucidated through the analyses of molluscan samples from six shell midden sites in the two study areas. The results of these analyses, combined with the spatial and functional analysis of shell middens, document changes in subsistence-settlement patterns and help to understand the changing process from coastal fishing-hunting subsistence to agricultural economies in southeastern Korea.

The traditional interpretation for the beginning of agriculture in Korea is that a nomadic group with a package of material culture that included new types of pottery, bronze technology, megalithic tombs, and rice agriculture migrated from northern China and replaced the existing hunter-gatherers (e.g., Kim 1986). One of the major problems of this traditional view is that it explains the transition in terms of colonization, focusing heavily on the dating and routes of the colonization, while it ignores the conditions, processes, and consequences for the adoption of agriculture. It fails to explain what conditions or causes made farmers move to new areas, or how they were able to replace or assimilate existing hunter-gatherers. Nor does this model try to understand the conditions of hunter-gatherers prior to the introduction of agriculture and how they reacted or adapted to the new subsistence system.

Recently it has been proposed that an imbalance between population and resources caused by the changing environment (Choe 1990) or increasing population (Norton 1996), was the major reason for the agricultural transition in Korea. As these hypotheses suggested, there is some evidence of changes in the climate, environment, and population structure during the transitional period. Yet it is not clear whether these changes resulted in any substantial imbalance between human populations and natural resource availability. Neither hypothesis provides any direct evidence for increasing population pressure, but simply assumes that climatic changes or population growth resulted in population pressure. In this respect, current population pressure models fail to demonstrate that population growth or environmental change led to any serious resource stress on the Chulmun people.

As traditional models for explaining the agricultural transition in Korea have failed to explain the underlying causes and complex processes of agricultural transition in Korea, an alternative model is required that addresses three significant changes evident at the time of the agricultural transition in Korea: (1) climatic/environmental changes, (2) population growth, and (3) the emergence of social inequality. Here I argue that the transition to agriculture in prehistoric Korea involved diverse strategies to deal with resource stress due to environmental changes and/or increases in population density, and increasing social complexity. These strategies can be identified through analysis of subsistence changes and settlement pattern studies.

Changes in Shell Midden Site Pattern

In order to examine long-term subsistence changes during the Chulmun period, this study describes prehistoric spatial and functional organisation of shell middens and their temporal changes in two study areas: Pusan-Kimhae and Kosong-T'ongyong (Fig. 1). These two specific areas were selected for the following reasons. First, systematic surveys undertaken on a regional scale have documented sufficient numbers of shell midden sites required for regional analysis of site patterns. Second, archaeological shell midden sites with abundant shell and faunal remains provide excellent data for detailed studies of prehistoric subsistence patterns. In addition, most shell midden sites from the area contain deposits from two or more subperiods in the Chulmun period, allowing examination of subsistence changes through time. Third, these two study areas experienced different environmental changes along with distinct developmental phases of agriculture and social complexity. Because of these unique contributing factors, I expected that the transition to agriculture could be illuminated by comparing and contrasting the changing patterns between these two areas.

Using data from 77 shell midden sites in the two study areas, I present quantitative analyses of four aspects of the sites: (1) site frequencies per period, (2) variation in site size through time, (3) the distribution of shell midden sites over the landscape during each period, and (4) temporal changes in site function. Using these data, spatio-temporal variation of shell midden patterns in the two study areas are characterized and compared. The results of this comparison demonstrate that changes in shellfish exploitation patterns differed in the two areas, illuminating the various ways that people in these two areas modified their subsistence strategies during the Chulmun period.

The Classification of Shell Midden Types

From ethnoarchaeological research in Anbarra, Australia, Meehan (1982, 112–8) categorizes shell midden sites into three types: (1) dinnertime camps, (2) processing sites, and (3) home bases. Dinnertime camps are the places where small groups of people from home bases collect, process, and consume shellfish for single meals. They are usually occupied only one time, although some are visited repeatedly. Some dinnertime camps relate to fishing activities, as people consume shellfish for snacks during or after fishing. Most dinnertime camps are located near shell habitats, and contain simple structures such as a few temporary hearths with shell debris scattered around them. Implements associated with shellfish exploitation and processing could be left at the sites.

Processing sites relate specifically to the processing of shellfish before transporting only the meat back to home bases. Some shellfish would be consumed at the site, but the major activity here is the processing. The processing

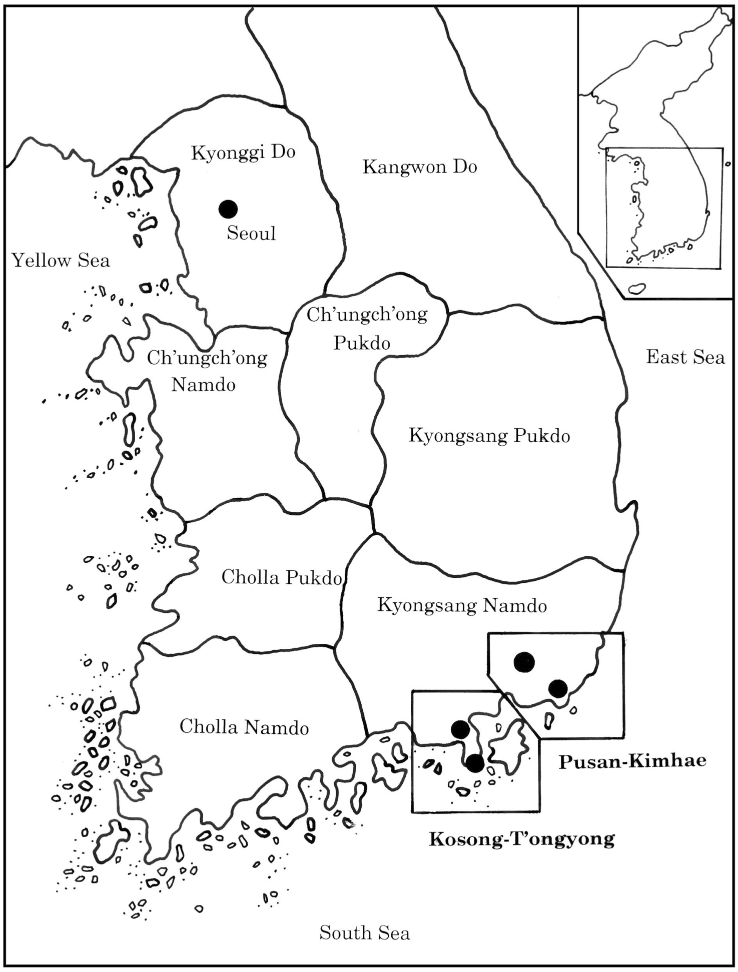

Fig. 1. Contemporary South Korean Provinces and the study area.

activity consists of opening the shells and extracting the flesh, and sometimes involves cooking the shells for easier processing. Like dinnertime camps, processing sites are situated adjacent to shell habitats. The structure at the site is simple, with several hearths and piles of shell debris. Meehan (1982, 117) notes that most processing sites at Anbarra contain the remains of a single species of shellfish.

Home bases are habitation sites where people conduct a variety of activities, including the processing and consumption of shellfish. Shellfish procured from nearby shell habitats can be brought back whole, and are processed and consumed near the residential area. This does not always imply that all shellfish are transported to home bases. Some shellfish consumed at home bases could be processed at the processing sites. Structures at home bases include settlements, hearths, and the debris of various subsistence, manufacturing, and maintenance activities. Since the processing of shellfish and other activities are repeated over a long period of occupation, the disposal pattern at home bases is complicated. Shellfish and other food resources are cooked in a hearth and the remains are usually left there for some time. The entire habitation area is regularly cleaned up and the debris dumped in peripheral areas. This process creates large heaps of refuse, and results in the mixing of more recent debris with earlier waste.

This categorization of shell middens by Meehan is instrumental in bringing behavioural factors related to shellfish exploitation into the functional analysis of prehistoric shell middens. However, since the scheme was derived from a single ethnoarchaeological example of a society with a relatively simple economy, this classification is too simplistic for understanding the characteristics of various shell midden types and functions in more complex economies. To develop a more comprehensive shell midden site function model, shell midden types can be characterized with respect to hunter-gatherer mobility patterns.

Binford (1980, 1982) discusses two types of hunter-gatherer mobility patterns: residential and logistical. Residential mobility is defined as the movement of the entire group from one location to another, and logistical mobility refers to the movement of individuals or small

	Base camps	Residence camps	Processing locations
activities	shellfishing & diverse activities beyond given habitat	shellfishing & diverse activities within given habitat	shellfishing only
tool/ feature	high diversity high evenness	medium diversity medium evenness	low diversity low evenness

Fig. 2. Suggested shell midden site function classification (modified from Binford 1980, 1982; Carlson 1979; Meehan 1982).

groups from the residential location to perform a specific task. People applying a residential mobility strategy make frequent residential moves with few logistical moves. They move their base camps from one location and relocate at another spot when the distance to a major resource exceeds the foraging range. People practicing logistical mobility, on the other hand, make few residential moves with many logistical moves. The main population stays at the base camp, while special task-oriented groups exploit resources located beyond the foraging range by leaving and returning to the base camp.

It is to be expected that each mobility strategy would generate different types of sites. Binford (1980) suggests that a residential mobility strategy produces base camps (or residence camps, Carlson 1979) and resource acquisition locations. A logistical mobility strategy produces base camps, locations, various specialized task-oriented field camps, resource monitoring stations, and caches for storing tools and food.

Base camps for each strategy can be differentiated by the range of subsistence activities (Chatters 1987). At residence camps, when practicing a strategy of residential mobility, people living at the base camp exploit resources mostly within the site's immediate surroundings. Archaeological manifestations thus reflect preparation, processing, and consumption activities related to those limited resources. When practicing a strategy of logistic mobility people can be expected to leave evidence from a variety of activities related to the exploitation and consumption of resources procured from diverse habitats beyond the camp's own setting. Some processing of resources is expected at such camps, although most processing would take place at specialized task-oriented field camps.

From this discussion of mobility strategies, the shell midden site classification by Meehan can be refined according to the scheme in Fig. 2. In an archaeological context, however, we experience some limitations in differentiating all of these site types. First, few remains of dinnertime camps are archaeologically visible unless they are visited repeatedly over a long period. In the case of repeated use, the archaeological evidence at dinnertime camps would be almost identical to those at processing sites. Secondly, it is difficult to separate the three possible types of processing sites: field camps and locations in the logistical mobility strategy and locations in the residential mobility strategy. Field camps, where special task-oriented groups for shell fishing processing temporarily maintain themselves while away from the base camps, could have evidence of more diverse activities than other locations, but not necessarily. There is no straightforward means for differentiating the shellfish acquisition locations related to either mobility strategy.

In light of this, the site function classification developed for the shell midden sites includes three types of sites: (1) base camps of the logistical mobility strategy, (2) residence camps of the residential mobility strategy, and (3) shellfish processing locations of both strategies. Base camps are defined as the habitation sites where people practice various subsistence activities, including shellfish exploitation. It is likely that the duration of occupation of base camps of the logistical mobility strategy is relatively long, lasting for more than one shell fishing season. Residence camps of the residential mobility strategy are occupied only during the shellfish exploitation season, and their subsistence activities consist mainly of shell fishing. Shellfish processing locations refer to non-habitation sites where people from base or residence camps procured and processed shellfish resources, then carried meat back to habitation sites.

Each type of shell midden site is expected to produce different archaeological manifestations (Fig. 2). Diversity in tool and feature assemblage, measured by richness and evenness, is the most apparent measure for inferring the site function (Chatters 1987). This is based on the assumption that assemblage diversity has an inverse relationship with residential mobility: as mobility increases, diversity decreases (Shott 1986).

At base camps, various implements and facilities are required for residence, maintenance, tool manufacturing and repairing, and food procurement, processing, and consumption, etc. Hence, high diversity in numbers of tool and feature types with even representation is expected from the assemblages recovered from base camps. Features for residential use, such as settlements and hearths, are likely. If a site is occupied for a long duration or is repeatedly occupied year after year, we can predict more permanently constructed structures and communal structures such as cemeteries. Residence camps, which were focused more on a single task than were base camps, would feature less diverse and less even representations of tool and feature assemblages than at base camps. Settlements would be expected. We can still anticipate durable structures and communal structures for the residence camps where people intended to return repeatedly over a number of years. At shellfish processing locations, activities are narrowly focused on procurement and processing of shellfish resources. This limited range of activities required only a few specialized implements and facilities. Therefore, we can predict the least diversity and evenness of tool and feature assemblage at processing locations. Since no residential activities are assumed, processing locations are expected to be free of settlements or communal structures. Hearths for shellfish processing could be visible here.

Based on the above discussion, diversity in tools and feature assemblage is tested using statistical analysis to infer the function or functions that were performed at a given shell midden site. Lithic and bone tools were chosen for testing tool diversity, since they provide the most relevant data for classification and quantification. Pottery was not used as raw data, since the sites from the study area have little adequately classified data for a functional study of pottery. Shell and wooden tools were excluded because of their rarity in shell middens in the study area.

Pusan-Kimhae Area

Based on the analysis of the spatio-temporal variation of shell midden frequencies, site sizes, locations, and functions (Lee 2001), I examine shell midden patterns directly according to the distribution of sites across the prehistoric landscape. Fig. 3 through 6 present site distributions by period for the Pusan-Kimhae area. Fig. 3 shows the distribution of the Incipient Chulmun (6000 to 4500 BC) sites in the Pusan-Kimhae area. Sites tend to be concentrated in two clusters. Sites in each cluster are located within a 10 km radius from the two major sites of each cluster: Tongsam-dong and Pombang. The site cluster around Tongsam-dong is located on Yong-do Island and adjacent coasts, and faces the outer coasts. The other cluster around Pombang is on the western coast of a prehistoric bay located what is now the Naktong River mouth, which is a more inner coast area. Sea level during the Incipient Chulmun period was much lower than the present sea level. The surrounding environment of sites was more terrestrial than we see today (Ban and Kwak 1991; Ota, Umitsu and Matsushima 1990; Shimoyama 1991). Most sites had efficient access to diverse habitats of both marine and terrestrial environments. Long-term occupation at these locations could be possible with high productivity from diverse habitats.

Most sites are base camps or residence camps of medium to large size, indicating that the duration of occupation at the shell midden sites was relatively long, at least during the shell fishing season. Since no archaeological features suggesting settlement have been reported, it is difficult to conclude that these sites served as long-term habitations. It is possible that village sites were developed adjacent to shell middens, but such villages have not been identified yet. If these sites were not places of long-term occupation, we can surmise that the Incipient Chulmun people moved between inland and coastal habitation camps seasonally, following their major seasonal subsistence resources. In any case, it is clear that shell fishing had been a major subsistence strategy at least seasonally since the Incipient Chulmun period.

Early Chulmun (4500 to 3500 BC) site distribution in the Pusan-Kimhae area as depicted in Fig. 4 shows a similar pattern to that of the Incipient Chulmun period. All sites are still located in two major clusters. The site function is not clear except at the Tongsam-dong site, which was a residence camp.

For the Middle Chulmun period (3500 to 2500 BC), the general pattern of two clusters is still apparent. Base camps and residence camps of large to medium size dominate, but processing locations are identifiable for the first time (Fig. 5). This period is when sea level was approximately 1 m higher than the present sea level (Ban and Kwak 1991; Ota, Umitsu and Matsushima 1990; Shimoyama 1991). The bay area had more outer coastal characteristics during this period, and the productivity of and accessibility to marine resources was greater. Residential stability appears to have increased both at the Tongsam-dong and Pombang sites, as they functioned more as base camps than during previous periods. This reflects the trend that major existing sites became more stable during this period as inhabitants increased the exploitation of coastal habitats.

On the other hand, the presence of processing locations indicates that a different subsistence strategy developed simultaneously in the inland zone. Archaeological and ethnographical evidence has shown that shellfish gatherers select their camp sites adjacent to shell beds or process shellfish at the coast and carry only the meat to camp. When the habitation site is located less than 3 km from the shell beds, shellfish are commonly brought back to the site, shell and all. If the habitation site is 3 to 3.5 km from the shell beds, shellfish are first prepared at processing locations and the shells are discarded and only the meat is brought to back to the base camps (Bigalke 1973; Gould 1980; Meehan 1977, 1982; Voigt 1982). From this observation, we can predict that the related base camps of the observed processing locations were located more than 3 km from the coast, probably in a more inland zone. This indicates that the subsistence strategies of these sites were more focused on the terrestrial habitats, and coastal

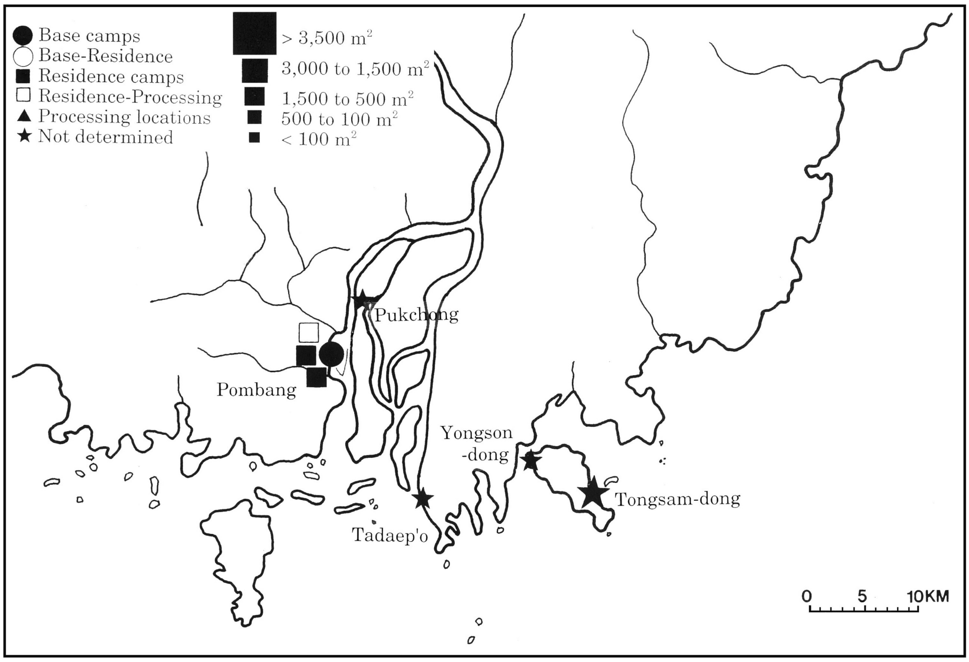

Fig. 3. Shell midden distribution for the Incipient Chulmun period in the Pusan-Kimhae area.

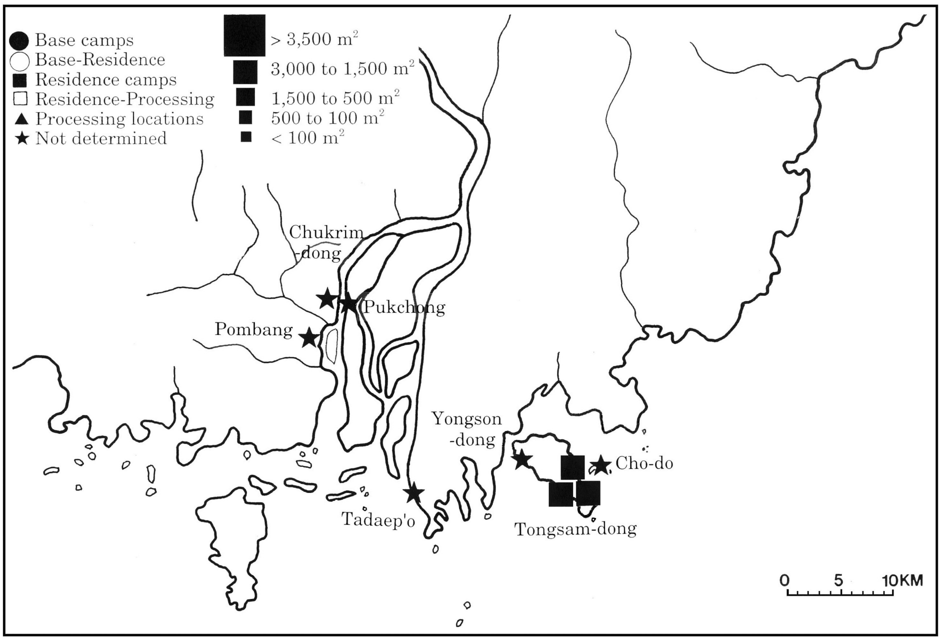

Fig. 4. Shell midden distribution for the Early Chulmun period in the Pusan-Kimhae area.

habitats were exploited sparsely through some processing locations.

Looking at the distribution of the Late Chulmun (2500 to 1300 BC) shell midden sites, we can conclude that the terrestrial-oriented subsistence strategies developed from the Middle Chulmun expanded during the Late Chulmun period (Fig. 6). The exploitation territory gradually shifted from marine-oriented to terrestrial-oriented in the Late Chulmun period. Even though the sea level was lower than during the Middle Chulmun, the location of Late Chulmun sites tends to be in a more inland direction in each cluster. New sites were located at the inland

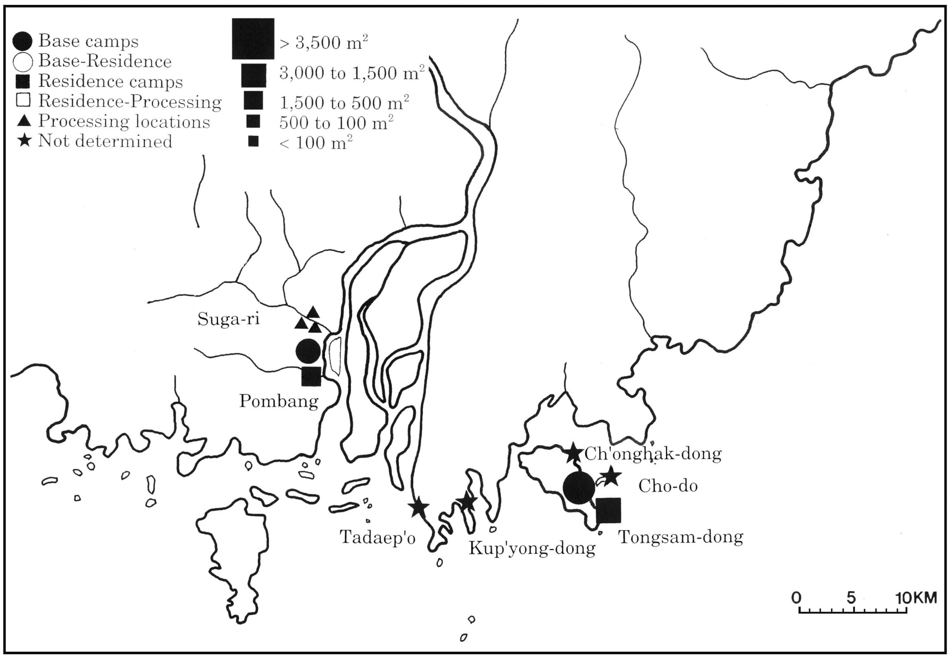

Fig. 5. Shell midden distribution for the Middle Chulmun period in the Pusan-Kimhae area.

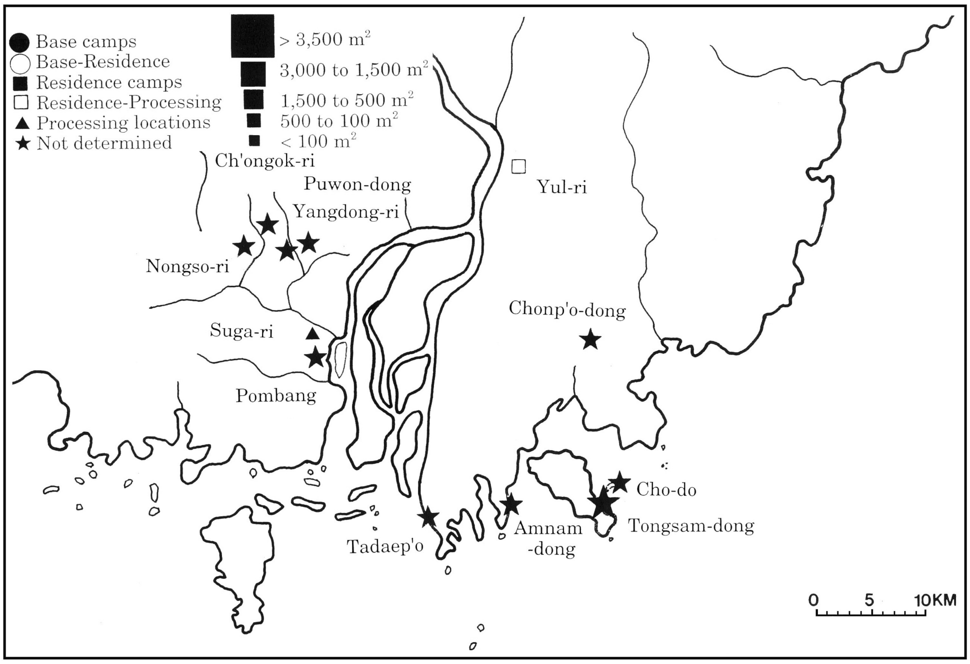

Fig. 6. Shell midden distribution for the Late Chulmun period in the Pusan-Kimhae area.

direction on the boundaries of two clusters. Also, one new site appeared outside of the existing two clusters, and it is in a more inland area where no shell middens were previously located.

Most Late Chulmun shell middens were smaller in size and had shorter occupation durations than in previous periods. Late Chulmun people evidently made their base camps at inland zones as the importance of terrestrial resources in their diet increased. The Late Chulmun people no longer preferred to locate their base camps

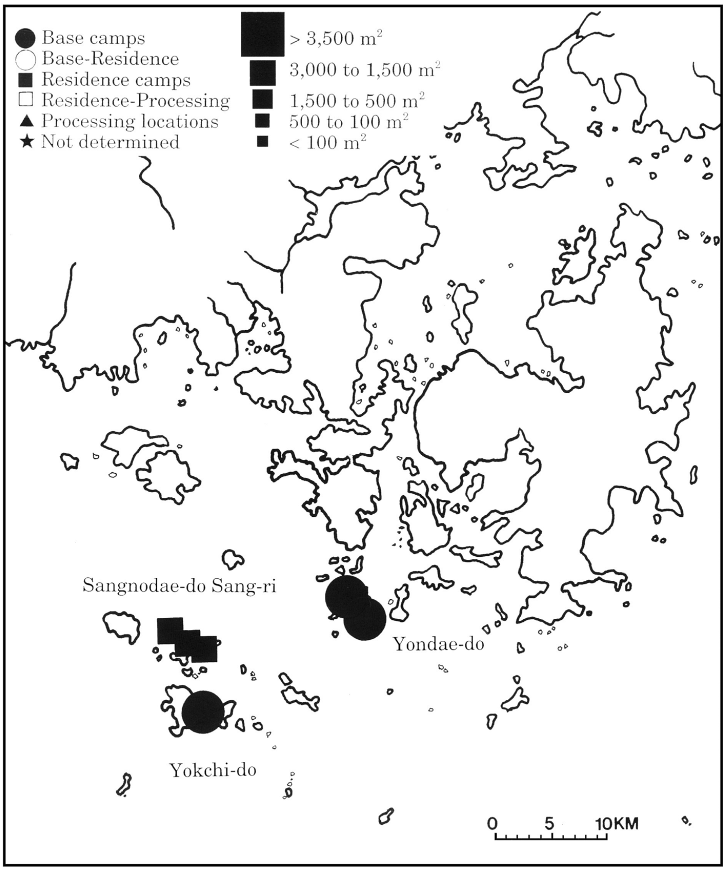

Fig. 7. Shell midden distribution for the Incipient Chulmun period in the Kosong-T'ongyong area.

adjacent to the shellfish exploitation area. Shellfish resources were exploited and processed at the processing locations or residence camps which people occupied for short periods, and were transported to the base camps located in the inland zone. Thus we can infer that the importance of shellfish in the diet apparently decreased.

This new subsistence system stabilized during the Late Chulmun, and a terrestrial economy entirely replaced the previous shellfish exploitation system during the following Mumun period (1300 to 300 BC). The Pusan-Kimhae area shows a complete absence of Mumun shell middens. The Mumun period presented an entirely new subsistence system, as people discarded shell fishing from their subsistence strategy.

Kosong-T'ongyong Area

The distribution of the Incipient Chulmun (6000 to 4500 BC) sites at the Kosong-T'ongyong area is shown in Fig. 7. Sites tend to be concentrated in two clusters. One is in the open sea islands around Yokchi-do Island, and the other is inland sea islands around Yondae-do Island. Sites are very large in their size, and all of them were base camps or residence camps. The Kosong-T'ongyong area had featured large-sized coastal habitation sites since the Incipient Chulmun period, due to the high productivity of marine resources in this area. The availability of various fish and sea mammals made the productivity in this area much higher than that of any other area of Korean peninsula. During the Incipient Chulmun, the sea level was much lower than today. The landmass of the islands was much larger than in any following period. Also the distance to the mainland was much closer. These factors greatly increased the accessibility of terrestrial resources. The Incipient Chulmun people could exploit terrestrial resources from the adjacent large size islands or the mainland by travelling from their base camp in the islands or moving their base camps seasonally to those areas. We have not discovered any sites from this area yet, but these areas need more systematic surveys.

The Early Chulmun period (4500 to 3500 BC) presented a pattern very similar to the Incipient Period (Fig. 8). Two clusters was still the major trend. Outside of the two clusters, one small-sized site was identified. Most sites remained base camps or residence camps. Site frequency rapidly increased beginning in the Middle Chulmun period (3500 to 2500 BC) (Fig. 9). New sites were identified in two clusters from adjacent small islands. In addition, the far outer islands were exploited. Since these islands are very small in size and are not

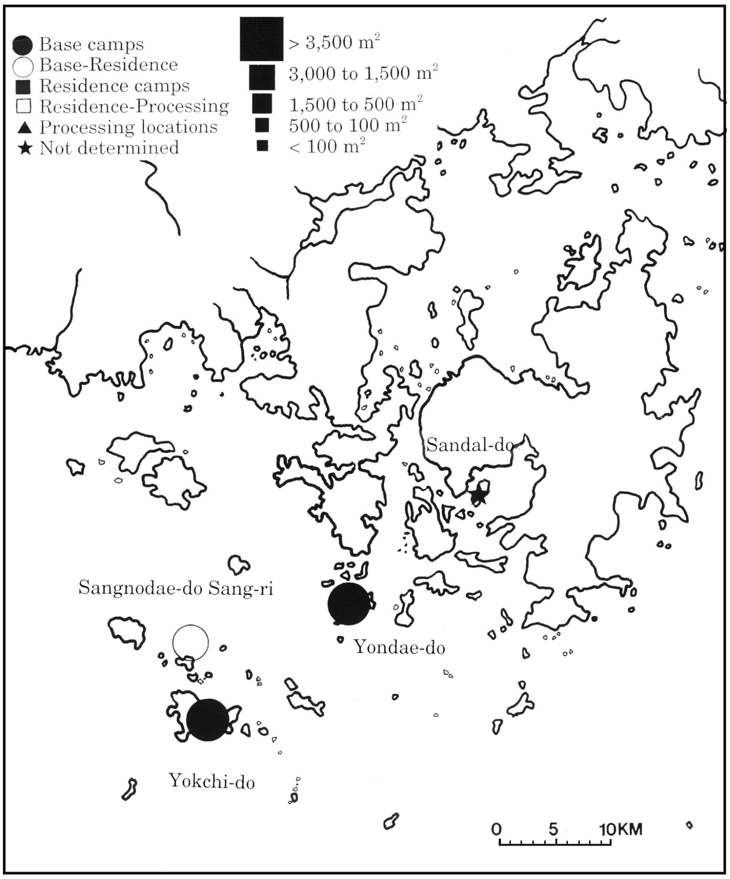

Fig. 8. Shell midden distribution for the Early Chulmun period in the Kosong-T'ongyong area.

suitable for occupation, I interpret them as having been processing locations. There is no quantitative data for the site function of major sites, such as Yokchi-do, Yondae-do, and Sangnodae-do. Since they show a continuity of artefact assemblages and site size, it is more likely that they functioned as base camps continuously through from previous periods.

Therefore, the site distribution of the Middle Chulmun period was characterized by continuing large-sized base camps and the addition of small-sized processing locations in the new territory. Increasing exploitation of less favoured and more costly habitats to exploit, including small islands and many outer coast sites at farther distances, indicates that more intensive exploitation of marine resources was practiced during this period. The rapid increase in site frequency seems to reflect an increase in population in the area, likely requiring people to intensify their existing subsistence strategy. This pattern intensified during the Late Chulmun period (2500 to 1300 BC). The site distribution in Fig. 10 shows that more peripheral areas were exploited. There were still some base or residence camps at existing locations and the centre of shell midden locations did not change, but more processing locations were developed.

The function of most, if not all, shell midden sites shifted to small sized, short term processing locations during the Mumun period (1300 to 300 BC) (Fig. 11). Even though site frequency increased, it is clear that shellfish exploitation decreased dramatically in the Mumun period. This indicates that overall subsistence shifted to a terrestrially oriented strategy. No Mumun habitation sites have been excavated from this area, but it is highly possible that large islands or adjacent mainland coastal areas contain non-shell bearing habitation sites dating to the Mumun period. From these sites, shell fishing was conducted by task groups procuring a supplementary food source.

Summary

To summarize the patterns described above, the two study areas show different trajectories of change in their shell midden site patterns. This indicates that people in the two areas modified their subsistence strategies in different ways across the transition from Chulmun to Mumun periods. In the Pusan-Kimhae area, the exploitation of marine resources including shellfish had been one of the major subsistence resources since the Incipient Chulmun period. During the Middle Chulmun period, the

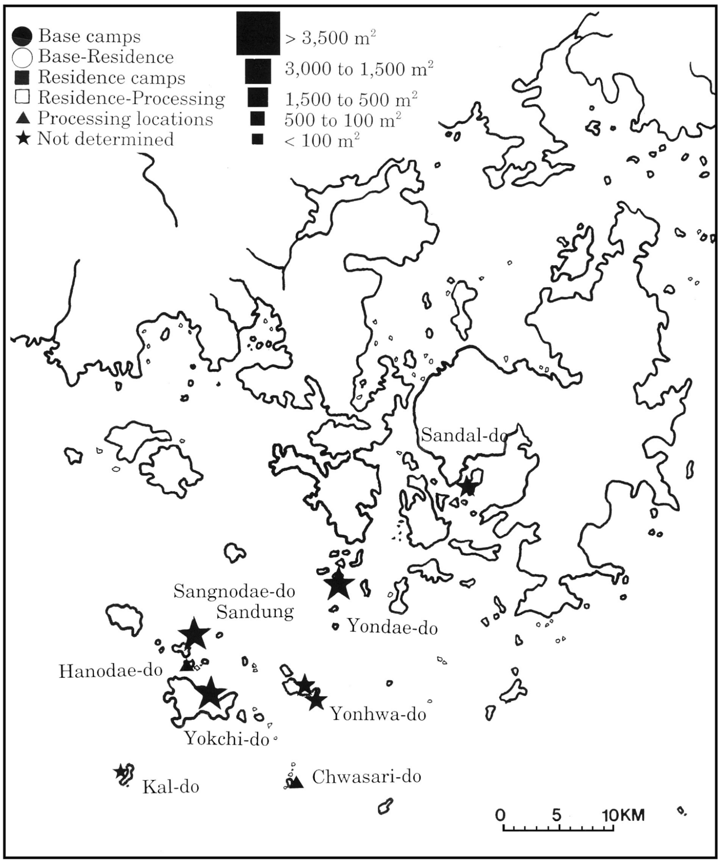

Fig. 9. Shell midden distribution for the Middle Chulmun period in the Kosong-T'ongyong area.

dependency on marine habitats increased at some sites. At the same time, a new terrestrial-oriented subsistence strategy was developed in inland zones. This new strategy was expanded during the Late Chulmun period, and entirely replaced the existing marine oriented focus at the beginning of the Mumun period.

In the Kosong-T'ongyong area, the intensity of marine resource exploitation was much higher than in the Pusan-Kimhae area. From the Incipient Chulmun period, most shell midden sites appeared to be long-term habitation sites. During the Middle and Late Chulmun periods, this marine-oriented subsistence strategy was intensified due to an increase in population. In the following Mumun period, the exploitation of marine resources was drastically decreased, but was still practiced in a small way as part of the new terrestrial-oriented subsistence system.

Changes in Resource Exploitation Patterns

The second part of this study is an examination of shellfish exploitation patterns based on the analysis of molluscan samples. The results of this analysis combined with the spatial and functional analysis of shell middens presented in the previous section delineate changes in shellfish exploitation patterns and the process of subsistence change during the Chulmun period. To document shellfish exploitation patterns, molluscan samples from six shell midden sites in the two study areas were examined. Three aspects of each sample were quantified and compared among sites and study areas: (1) relative taxonomic abundance of molluscan species, (2) habitats exploited for molluscs, and (3) size of major shell species.

Pusan-Kimhae Area

Tongsam-dong

Shellfish exploitation patterns tend to be constant over long periods of time at Tongsam-dong, with mussel (*Mytilus coruscus*) comprising the largest proportion (59 to 80% of all edible species) and oyster (*Crassostrea gigas*) being the next most common species (13 to 29%). Turban shell (*Batillus cornutus*), top shell (*Chlorostoma argyrostoma lischkei*) and abalone (*Nordotis discus*) together contribute 5 to 14% of total shellfish remains. These five major species combined consistently make up about 98% of all species, while all others contribute less than 1% to the population (Fig. 12).

Molluscan exploitation patterns at Tongsam-dong highlight three categories of changes that developed from

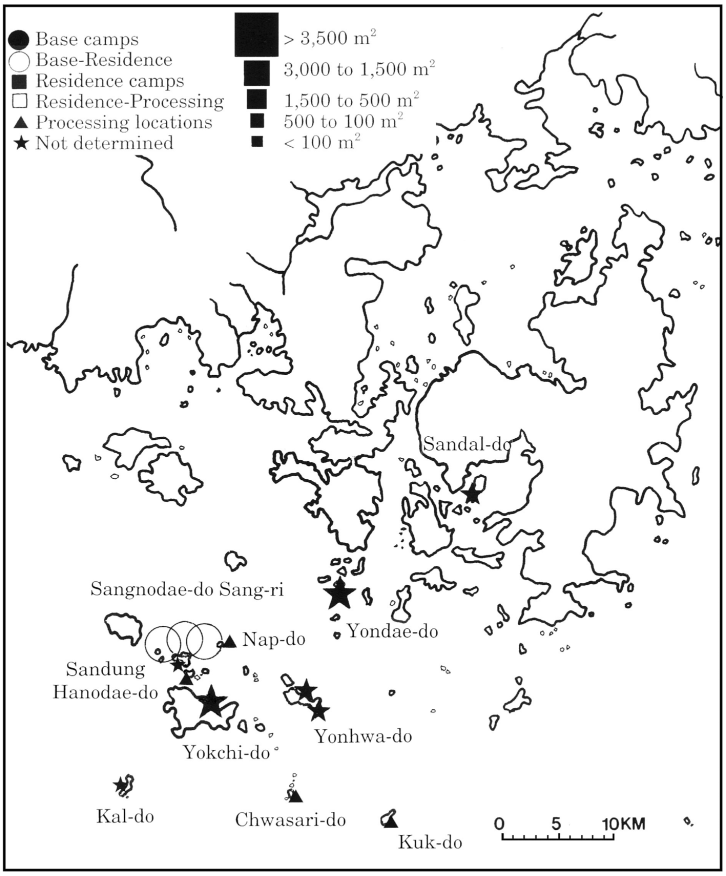

Fig. 10. Shell midden distribution for the Late Chulmun period in the Kosong-T'ongyong area.

the Mokdo (Early/Middle Chulmun) through the Yongdo (Late Chulmun) period. First, dependence upon the five major species remains strong, but proportional importance of each species has changed significantly (see Fig. 12 and 13). Mussel, a shell species most favoured by the Tongsam-dong people and most easily obtained from the site, shows a consistent decrease, contributing almost 20% less to the total shellfish population in the Late Chulmun than in the Early/Middle Chulmun. Oyster, abalone, top shell, and turban shell each increased in their contributions to the Late period diet. Among them, abalone and turban shell show the highest increase. Changes in proportions of mussel and oyster can be explained by environmental changes. As sea level decreased from the late Middle Chulmun period, mussels in the intertidal/subtidal zone would have diminished in number, whereas intertidal oysters increased in the surrounding habitats. However, increasing exploitation of abalone and turban shell stands in contradiction to expectations for sea level changes. Since abalone and turban shell inhabit the subtidal area, the increase of both abalone and turban shell surely reflects active exploitation of deep water species. I suggest that this changing pattern reflects increasing use of less preferred, less easily procured species.

Second, shellfish exploitation was increasingly focused on gastropods in later periods. One distinct characteristic of the Tongsam-dong site is the wide range of gastropods that were exploited and their relatively high proportional contribution to the total diet compared to other sites. In later periods, the number of gastropod types consumed is similar to that in previous times but the proportion increases, whereas the use of bivalves decreases in both number and proportion (see Fig. 12). Gastropods are usually less favoured for food than bivalves, as recognized archaeologically and ethnographically in Korea, since they are less easily procured and average meat volume to shell count is much less than in bivalves. With evidence of increasing exploitation of deep water species, this supports the proposition that the procurement of less preferred, less easily procured species increased by the Late Chulmun period.

Third, the number of shellfish species exploited was reduced to almost half in later periods (see Fig. 12). Typically, the use of less preferred and less easily procured species means more shellfish species are harvested from new habitats (e.g., Pombang and Sang-ri). Yet, at Tongsam-dong this usual pattern was undetected, and it is likely that overall shellfish exploitation decreased.

Changes in shellfish exploitation patterns at Tongsam-

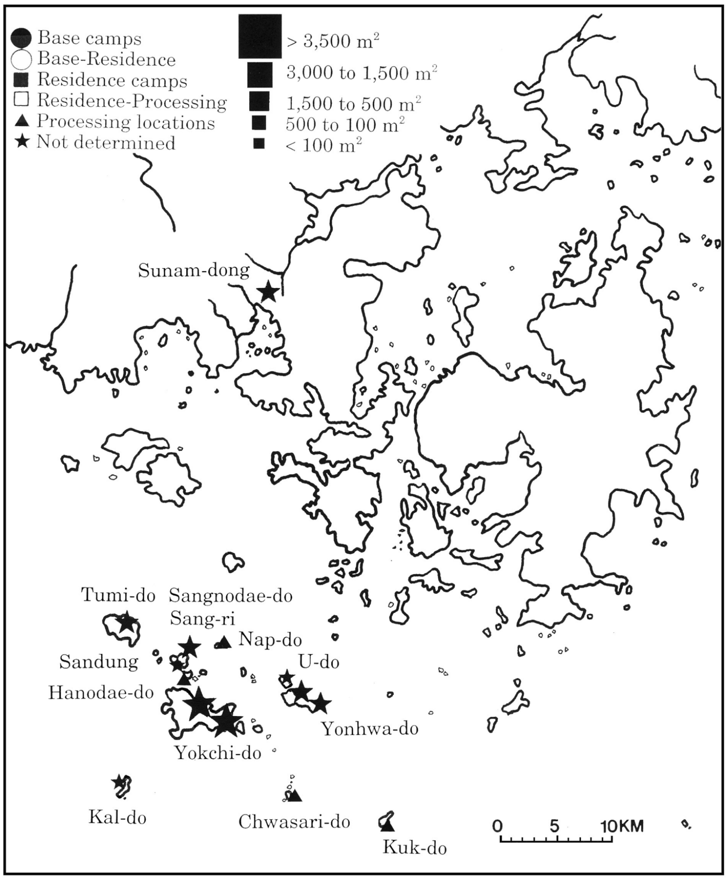

Fig. 11. Shell midden distribution for the Mumun period in the Kosong-T'ongyong area.

layer	shell species (#)	bivalve (#)	gastro-pod (#)	mussel (%)	oyster (%)	abalone (%)	turban shell (%)	top shell (%)
Yongdo (Late CM)	11	4	7	58.6	25.9	5.2	4.7	4.2
Tudo-Yongdo (Middle/Late)	13	5	8	59.7	28.8	5.6	4.8	0.7
Tudo (Middle CM)	18	10	8	63.3	22.4	4.7	4.0	3.0
Mokdo (Early CM)	20	8	12	79.6	13.2	1.5	0.8	3.1

Fig. 12. Relative abundance of major shell species from Tongsam-dong (after Sample 1974). Edible species only; CM = Chulmun.

dong are characterized by (1) decreasing shellfish exploitation, (2) decreasing number of exploited species, and (3) increasing use of less preferred, less easily procured shell species, including gastropods. As sea level declined after the late Middle Chulmun period, the major shellfish resource base – mussels that inhabited at the intertidal/subtidal zone – was not as productive as in previous times. Tongsam-dong inhabitants procured less preferred, less easily procured shellfish resources to compensate for decreased productivity of shellfish harvesting. However, there is no evidence that they attempted to intensify shellfish harvesting since the range

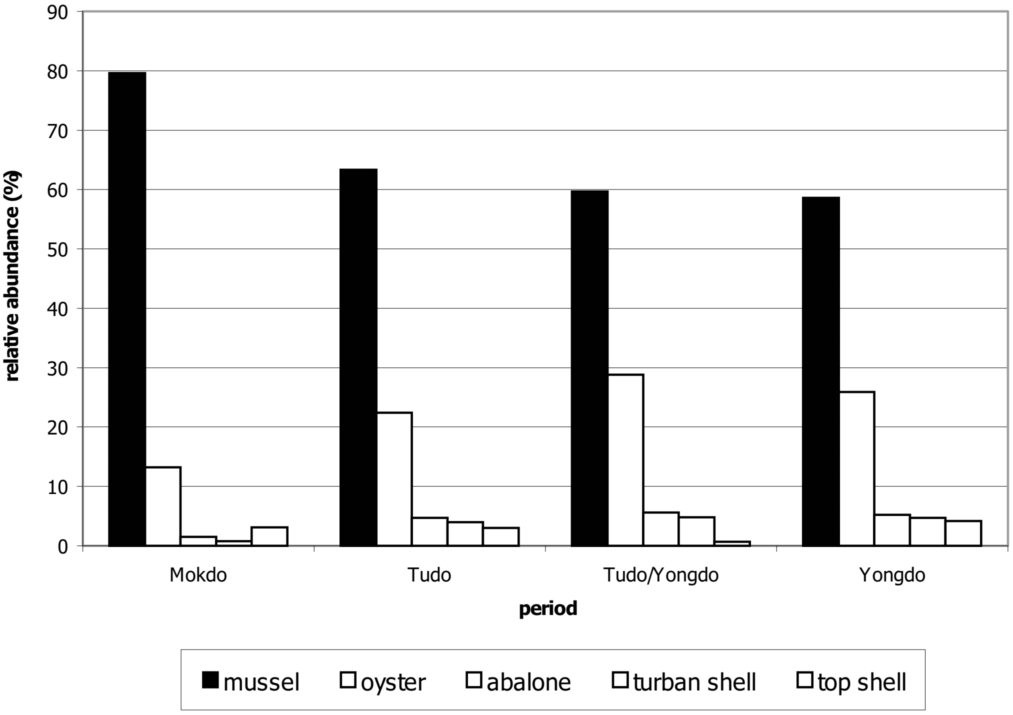

Fig. 13. Relative abundance of major shell species from Tongsam-dong.

of species exploited was reduced. Thus, overall shellfish exploitation decreased.

This changing pattern seems to be related to the overall shift from marine to terrestrial resources noted in site deposits above the Mokdo layer (Early/Middle Chulmun). Based upon the study of artefact and faunal assemblages, Sample (1974, 102, 118–120) and Shin (1994, 187–91) proposed that people during the Mokdo period exploited abundant land and marine resources including deer, wild boar, sea lion, whale, and fish of large marine species. After the Mokdo period, the proportion of land mammals appears to increase, while proportions of marine fauna decreased by 15 to 25% (see Fig. 14 and 15). Sea mammal hunting and fishing, which were so important in the Mokdo period, ceased to be major activities in later periods.

In summary, the shellfish exploitation pattern at Tongsam-dong indicates that the intensity of shellfish harvesting decreased during the late Middle and Late Chulmun periods. As the productivity of major shellfish resources declined with sea level changes, the exploitation of less preferred, less easily procured shellfish species increased temporarily, but overall shellfish use gradually decreased. Faunal data shows that the dependence on marine mammals and fish in the overall diet also decreased during the late Middle and Late Chulmun periods. It is clear that the subsistence strategy at Tongsam-dong underwent a major shift from a marine to terrestrial orientation during the late Middle and Late Chulmun periods.

Suga-ri

The molluscan exploitation pattern at Suga-ri is characterized by an extreme concentration on oysters. Oyster (*Crassostrea gigas* and *Crassostrea ariakensis*) comprise 96 to 99% of all edible shell species from all layers, while other shells make up less than 3% (Fig. 16). A narrow variety of shellfish species were exploited, with only two to four edible species represented in each archaeological layer. This selectivity seems to be related to site function. In the previous section, the Suga-ri site was categorized as a short term shellfish processing location. In contrast to base camps or residence camps where a variety of shell species are usually exploited, it is expected that shellfish gathering at processing locations was limited to a few if not a single species (Meehan 1982, 117). The shellfish exploitation pattern at Suga-ri is consistent with the expectation that people visited this processing location specifically for oyster collecting.

Three types of changes in shellfish exploitation patterns are evident in Fig. 16. First, the dominant shell species shifted from *Crassostrea ariakensis* during the early Middle Chulmun period to *Crassostrea gigas* during

layer	fish		marine mammal		land mammal	
	# of spp.	%	# of spp.	%	# of spp.	%
Yongdo (Late CM)	2	49.3	3	20.3	2	30.4
Tudo-Yongdo (Middle/Late CM)	3	7.1	3	54.1	3	38.8
Tudo (Middle CM)	6	20.8	3	41.1	3	38.1
Pusan (Early CM)	4	24.5	3	45.5	2	30.0
Mokdo (Early CM)	5	38.8	3	44.7	3	16.5
Chodo (Incipient CM)	3	11.7	3	38.3	2	50.0

Fig. 14. Relative abundance in NISP of major faunal species from Tongsam-dong (after Sample 1974). CM = Chulmun.

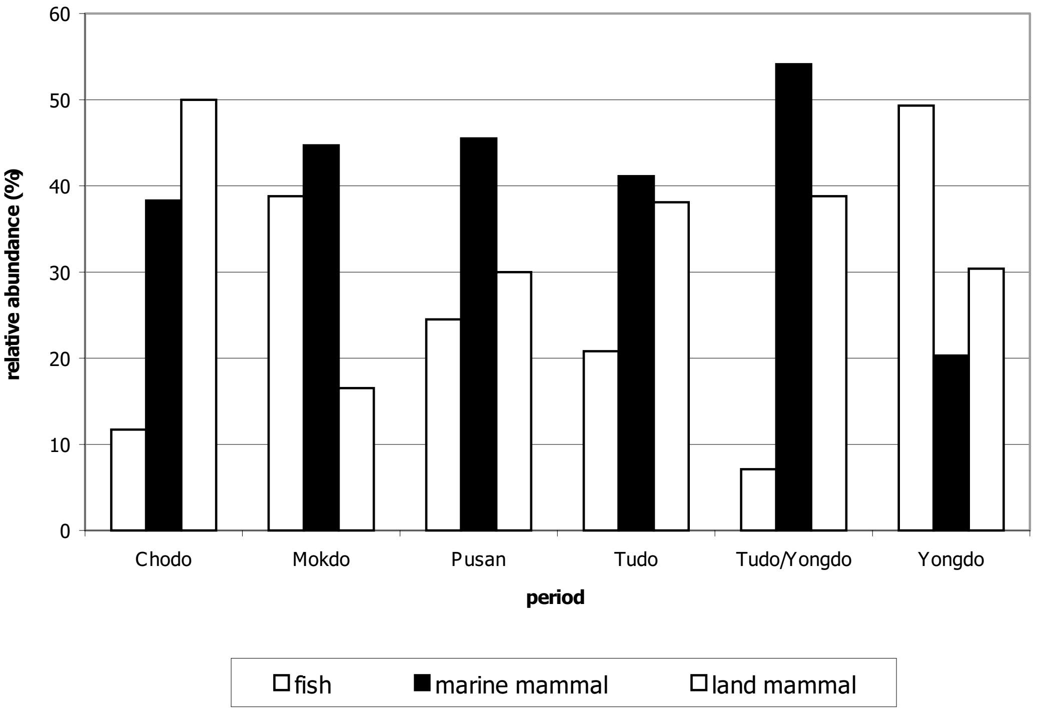

Fig. 15. Relative abundance in NISP of major faunal species from Tongsam-dong.

the late Middle and Late Chulmun periods. This shift appears to be related to the changes in adjacent shellfish habitat from intertidal/subtidal to intertidal as sea level declined. People in the early Middle Chulmun period collected *Crassostrea ariakensis*, an intertidal/subtidal type, which would have been more accessible during the high sea level period. However, they switched to *Crassostrea gigas*, an intertidal species of oyster, when lower sea levels altered oyster species composition around the site.

Second, the proportion of *Crassostrea ariakensis* increased significantly during the Late Chulmun period. Third, an increase in the occurrence of venus clam (*Tapes philippinarum*) was detected in Late Chulmun layers

layer	shell species (#)	bivalve (#)	gastropod (#)	*C. gigas* (%)	*C. ariakensis* (%)
Layer 1 (Late CM)	3*	3*	0	73.7	26.3
Layer 3 (late Middle CM)	4	3	1	99.6	–
Layer 4 (early/late Middle)	3	2	1	–	96.4
Layer 5 (early Middle CM)	2	2	0	–	99.6

*Fig. 16. Relative abundance of major shell species from Suga-ri (after Kaneko and Ushizawa 1981). Edible species only; CM = Chulmun. *A significant amount of venus clam (*Tapes philippinarum*) was recovered but not quantified (Kaneko and Ushizawa 1981: 254).*

layer	fish		marine mammal		land mammal	
	# of spp.	%	# of spp.	%	# of spp.	%
Layer 1 (Late CM)	0	0	0	0	3	100
Layer 2 (Late CM)	1	1.2	0	0	5	98.8
Layer 3 (late Middle CM)	2	1.1	0	0	4	98.9
Layer 4 (early/late Middle)	4	1.3	1	0.3	5	98.4
Layer 5 (early Middle CM)	5	2.7	1	1.5	3	96.8
Layer 6 (early Middle CM)	0	0	1	2.4	2	97.6

Fig. 17. Relative abundance in NISP of major faunal species from Suga-ri (after Kaneko and Ushizawa 1981). CM = Chulmun.

(even though it is not reflected in Fig. 16, since its shell is too fragile to generate numbers)(Kaneko and Ushizawa 1981, 254). Both *Crassostrea ariakensis* and *Tapes philippinarum* are intertidal/subtidal species that were not easily obtained with the low sea levels of the Late Chulmun. Addition of these two species in the Late Chulmun period, when sea level was even lower than the late Middle Chulmun period, reflects increasing use of less preferred, less easily procured species. Unlike Tongsam-dong, there was no evidence of decreasing productivity of major species to initiate this change. I return to a discussion of the possible causes of this change below.

The faunal assemblage shows that hunting of some land mammals, mostly wild boar and deer, was also practiced while people were visiting the Suga-ri site for oyster collecting. This terrestrial oriented subsistence pattern increased in later periods as sea level declined. The number and proportion of fish species exploited declined from the early Middle to the Late Chulmun

layer	shell species (#)	bivalve (#)	gastropod (#)	major species
Layer IV (Late CM)	6	4	2	*C. gigas* *C. ariakensis*
Layer III (Middle CM)	3	3	0	*C. gigas*
Layer II (Early/Middle CM)	3	3	0	*C. gigas* *C. ariakensis*
Layer I (Incipient/Early CM)	13	6	7	*C. gigas* *Ostrea d.*

Fig. 18. Major shell species exploited from Pombang (after Kaneko 1993). Edible species only; CM = Chulmun.

layer	species	mean height (mm)	sample size (# of shells)
Layer IV (Late CM)	*C. gigas* *C. ariakensis*	83	175
Layer III (Middle CM)	*C. gigas*	78	204
Layer I (Incipient/Early CM)	*C. gigas* *Ostrea d.*	75	109

Fig. 19. Size of oyster shells from Pombang (CM = Chulmun).

period, where no fish bones were recovered. Marine mammals were obtained only during the early Middle Chulmun period, when sea level reached its maximum height.

In summary, shellfish exploitation patterns at Suga-ri, a short-term processing location, are characterized by an extreme concentration on oysters. Increasing use of less preferred, less easily procured species is evident during the Late Chulmun period, but the reason for this change is not clear.

Pombang

Relative abundance of each shellfish species is not available at the Pombang site, but excavators described oyster as the dominant species (Ha, Lee, and Lee 1993, 23–29). My preliminary research on the Pombang faunal assemblage reveals that the Late Chulmun period included approximately 15% ark shell (*Tegillarca granosa*), venus clam (*Dosinorbis japonicus*), and veined rapa whelk (*Rapana venosa*). Oysters shells were not as prevalent here as at Suga-ri. This can be attributed to the functional differences between the two sites. Pombang had been used as a base camp or residence camp throughout its occupation, hence it is expected that its inhabitants exploited a greater variety shell species than Suga-ri site, which was a short term shellfish processing location.

The molluscan exploitation pattern indicates changes through time, especially from the Middle to the Late Chulmun period (Fig. 18). First, more diverse species including some gastropods were exploited in the Late Chulmun period. Second, more intertidal/subtidal species including *Crassostrea ariakensis* were added. Third, the size of oysters exploited gradually decreased, and some large species were added by the Late Chulmun period. Comparing oyster shell sizes, mean size gradually increased from the Incipient to the Late Chulmun period (Fig. 19). The distribution of shell size reveals a more complex picture. From the Incipient/Early to the Late Chulmun, the size of the oyster most exploited is reduced. However, some large shells were found in the Middle and Late Chulmun periods. The size of oyster shells usually exploited diminished, and new species or new locations were explored. At Suga-ri, the larger *Crassostrea ariakensis* was added to the small sized *Crassostrea gigas* in the Late Chulmun period. Fig. 18 indicates that the Middle Chulmun people at Pombang exploited only *Crassostrea gigas*, and *Crassostrea ariakensis* was added in the Late Chulmun period. Based

layer	fish	marine mammal	land mammal
Layer IV (Late CM)	1	1	2
Layer III (Middle CM)	3	0	2
Layer II (Early/Middle CM)	0	2	3
Layer I (Incipient/Early CM)	7	2	3

Fig. 20. Number of faunal species exploited from Pombang (after Kaneko 1993). CM = Chulmun.

on this pattern, I assume that Pombang people began to exploit large sized *Crassostrea ariakensis* as the size of *Crassostrea gigas* diminished. The reason behind the size reduction of intertidal type oysters is not clear. Both environmental changes by sea level decline and human overexploitation are possible, but difficult to determine with given data.

These changes through time indicate that shellfish harvesting was intensified at Pombang during the Late Chulmun period. As the productivity of major oyster species declined (as reflected in size reductions), Pombang people attempted to intensify overall shellfish exploitation by exploring more species and increasing the use of less preferred, less easily procured species. In addition, the decreased use of marine resources evident at Late Chulmun period Tongsam-dong and Suga-ri is also evident at Pombang. As no proportional data were available, I conducted preliminary analyses based on the changes in the number of faunal species exploited (Fig. 20). While there are no drastic changes in land mammals exploited, as wild boar and deer had been constant major species through time, the number of species of fish and marine mammal exploited apparently decreased in the Late Chulmun period. Fish remains show that several fish species were exploited during the Incipient/Early and Middle Chulmun periods, but only one species was found in the Late Chulmun layer. Marine mammals were abundant in the Incipient and Early Chulmun layers, but only one specimen was found from the Late Chulmun layer.

In summary, Pombang indicates (1) the intensification of shellfish exploitation with more diverse species procured and (2) decreased use of marine resources during the Late Chulmun period. At Tongsam-dong, this process began with decreasing productivity of major shell species. Pombang people intensified the exploitation of shellfish resources to overcome the resource shortage, whereas overall shell fishing was decreased at Tongsam-dong. However, overall subsistence gradually shifted to a terrestrial orientation.

shell species (#)	bivalve (#)	gastropod (#)	major species
8	5	3	*C. gigas*

Fig. 21. Major shell species exploited from Yul-ri (after Kim and Jeong 1980). Edible species only.

Yul-ri

The Yul-ri site dates to the Late Chulmun period or possibly the transitional period between Chulmun and Mumun. The incompleteness of the molluscan and faunal data makes it impossible to reconstruct complete subsistence patterns for the site. However, the location of shell middens toward the inland area and the exploitation of a small range of shellfish species indicate that the Late Chulmun people may have depended more upon terrestrial resources. Only eight species of shellfish were identified, among them five bivalve species and three gastropod species (Fig. 21). *Crassostrea gigas* (oyster) is the dominant species, with other species contributing only a few shells (Kim and Jeong 1980, 49–50).

The presence of four intertidal/subtidal zone species indicates that Yul-ri inhabitants exploited and transported some shellfish resources from remote areas. Even though the occurrence is low, this situation supports the interpretation that exploitation of less preferred and less easily

layer	shell species (#)	bivalve (#)	gastropod (#)	major species
Layer 2 (Late CM)	22	10	12	*C. gigas* *Ostrea d.*
Layer 3 (Late CM)	23	9	14	*C. gigas* *Ostrea d.*
Layer 4 (Late CM)	18	5	13	*C. gigas* *Ostrea d.*
Layer 5 (Early CM)	15	5	10	*C. gigas* *Ostrea d.*
Layer 6 (Incipient CM)	5	3	2	*C. gigas*
Layer 7 (Incipient CM)	6	3	3	*C. gigas*
Layer 8 (Incipient CM)	6	3	3	–

Fig. 22. Major shell species exploited from Sang-ri (after Son 1982). Edible species only; CM = Chulmun.

procured species was the general pattern during the Late Chulmun period in the Pusan-Kimhae area.

Summary

In summary, the general pattern in the Pusan-Kimhae area is that the productivity of major shellfish species declined during the Late Chulmun period. People attempted to intensify shellfish harvests by exploiting less preferred, less easily procured species. However, shellfish consumption gradually decreased and finally ceased at the beginning of the Mumun period. The overall subsistence orientation shifted from marine to terrestrial as the exploitation of marine resources decreased.

Kosong-T'ongyong Area

Sang-ri

The relative abundance of each shellfish species has not been reported for this site, except for Layer 2 (Late Chulmun) where oysters comprise 69% of all shellfish species. Excavators reported that oyster was the dominant species throughout, and mussel (*Mytilus coruscus*), venus clam (*Saxidomus purpuratus*), turban shell (*Batillus cornutus* and *Lunella coronata*) and murex (*Reishia bronni*) were the next most common species (Son 1982, 33). No Middle Chulmun deposit has been identified at the Sang-ri site. The Sandung site, located on an adjacent coast of the same island roughly 1.5 km from Sang-ri, has Middle and Late Chulmun deposits. This site has 18 species of shellfish, with oyster comprising the largest proportion and mussel being the next most abundant (Kim and Park 1989). This indicates that there were no drastic changes in general shell fishing patterns from the Early to the Late Chulmun periods on this island.

The molluscan exploitation pattern at Sang-ri indicates some minor changes through time (Fig. 22). First, the subtidal zone began to be actively exploited during the Late Chulmun period. Second, the number of shell species consumed, especially gastropods, dramatically increased from the Incipient to the Early Chulmun period. During the Late Chulmun period more species were added, but this latter increase included more bivalve species than gastropods. Sang-ri people began and continued to exploit new shellfish species at certain points, including abalone (*Nordotis discus*) from Layer 6, *Ostrea denselamellosa*, top shells (*Monodonta labio labio* and *Chlorostoma* sp.) and limpet (*Cellena* sp.) from Layer 5, venus clam (*Meretrix lusoria*) and top shell (*Omphalius* sp.) from Layer 4, and venus clam (*Gomphina veneriformis*) from Layer 3.

Changes in shellfish exploitation patterns at Sang-ri are characterized by the exploitation of more diverse shellfish species from more diverse habitats in the Late Chulmun period. This indicates that shellfish gathering was intensified by acquiring new species from new habitats. Unlike the Pusan-Kimhae area, this change was not initiated by a decrease in productivity. The productivity of major shellfish species was still high in the Late

layer	fish		marine mammal		land mammal	
	# of spp.	%	# of spp.	%	# of spp.	%
Layer 2 (Late CM)	9	59.1	4	18.7	8	22.2
Layer 3 (Late CM)	8	28.4	3	28.4	5	43.2
Layer 4 (Late CM)	4	8.8	3	29.8	5	61.4
Layer 5 (Early CM)	7	33.3	3	21.3	3	45.4
Layer 9 (Incipient CM)	3	33.3	3	29.2	2	37.5

Fig. 23. Relative abundance in NISP of major faunal species from Sang-ri (after Son 1982). CM = Chulmun.

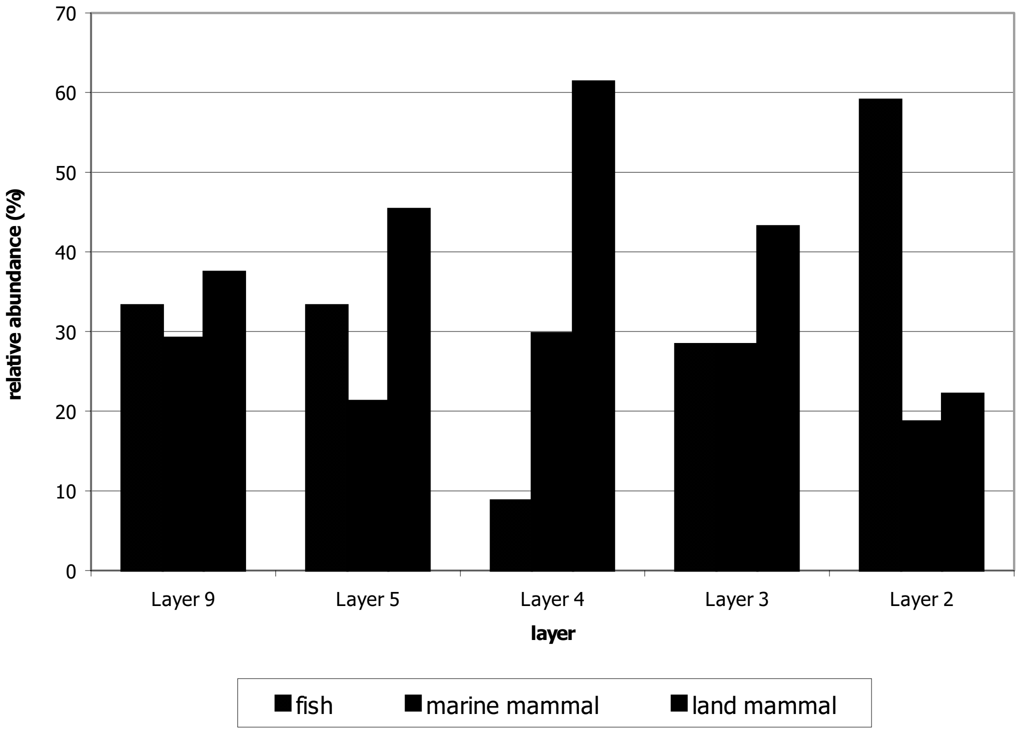

Fig. 24. Relative abundance in NISP of major faunal species from Sang-ri.

Chulmun period, as evident in the size of shell present in middens.

In addition, the exploitation of marine resources, especially fish resources, was intensified at the same time. Shin (1994, 186) argues that Sang-ri people intensified their overall subsistence strategy in the Late Chulmun period, based upon the fact that there was an increase in the number of species of fish consumed, as well as marine and terrestrial mammals. My assessment of faunal remains from Layer 4 to Layer 2 in the Late Chulmun period is that fishing was intensified as the number of exploited species and the proportion to the total population sharply increased (Fig. 23 and 24). However, the intensification of marine and terrestrial mammals is not clearly indicated, since only a few new species with low occurrences were added and their contribution to the diet decreased. It is more likely that the importance of land mammals in the overall subsistence economy de-

shell species (#)	bivalve (#)	gastropod (#)	*C. gigas* (%)	mussel (%)
7	3	4	85.2	14.0

Fig. 25. Relative abundance of major shell species from Yondae-do (after An 1993). Edible species only.

layer	fish		marine mammal		land mammal	
	# of spp.	%	# of spp.	%	# of spp.	%
G-M pits Layer 4 (Early/Middle CM)	20	77.8	6	6.9	7	15.3
P-U pits Layer 2 (Early/Middle CM)	13	76.1	5	7.5	6	16.4
P-U pits Layer 3 & 4 (Incipient/Early CM)	20	74.3	5	8.6	6	17.1

Fig. 26. Relative abundance in MNI of major faunal species from Yondae-do (after Kaneko and Seo 1993). CM = Chulmun.

creased during the Late Chulmun period. This pattern contrasts with the Pusan-Kimhae area where decreased exploitation of marine resources and increased use of terrestrial resources was evident.

In summary, the overall subsistence pattern at Sang-ri during the Late Chulmun period is characterized by the intensification of marine resource exploitation, especially shellfish and fish. Even though major molluscan species maintained high productivity until the Late Chulmun period, Sang-ri people intensified shellfish gathering as they exploited more diverse species from more diverse habitats.

Yondae-do

At Yondae-do, oyster (*Crassostrea gigas*) is the dominant species, comprising 85% of the total edible shellfish resources. Mussel (*Mytilus coruscus*) is the next most common species (14%). Other shell species make up less than 1% of the total (Fig. 25). A small range of molluscs was exploited, similar to the Incipient and Early Chulmun layers at Sang-ri. Faunal samples quantified by NISP (Kaneko and Seo 1993, 321–377) show that, compared to the Incipient and Early Chulmun layers at Sang-ri, Yondae-do people depended on fish more than Sang-ri people did. However, dependency on marine and terrestrial animals at Yondae-do was much less than at Sang-ri (Fig. 26).

Shellfish exploitation patterns during the Incipient and Early Chulmun periods in the Kosong-T'ongyong area are documented by data from Yondae-do as well as the early layers from Sang-ri. These data indicate that a small range of shellfish species were obtained from adjacent habitats. This pattern is very similar to that observed in the Incipient and Early Chulmun periods in the Pusan-Kimhae area.

Summary

The Kosong-T'ongyong area shows different directional change in shellfish exploitation than the Pusan-Kimhae area. The productivity of shellfish and marine resources remained high until the Late Chulmun period. However, people intensified both shell fishing and fishing by procuring more diverse species from more diverse habitats during the Late Chulmun period.

Changes in Subsistence-Settlement System

Results of the analyses conducted in this study on aggregate suggest that the Chulmun coastal foragers in the study areas shared two processes of change in their subsistence-settlement systems. First, both areas show a relatively rapid and drastic transition from marine-oriented to terrestrial-oriented subsistence strategy during the Late Chulmun period. Second, residential bases moved from coastal areas to inland areas. Coastal areas were no longer intensively occupied, but were exploited as processing locations for marine resource exploitation on a small scale.

The Pusan-Kimhae area shows a relatively rapid and drastic transition from a marine-oriented to terrestrial-oriented subsistence strategy. During the Late Chulmun period, the importance of both shellfish and marine resource exploitation, i.e., fishing and marine mammal hunting, in the overall subsistence was apparently reduced. The following Mumun period provides no evidence for the exploitation of marine resources. The overall subsistence strategy in the area entirely shifted to terrestrial resources.

Environmental changes due to sea level decline appear to initiate this process. As sea level declined more than 1 m from the Middle to the Late Chulmun period, the environment of the area became less suitable for marine resources. This is evident in the size reduction of major shellfish species during the Late Chulmun period. It is expected that the productivity of marine mammals and fish whose habitat was the subtidal zone was also reduced. The decreasing productivity of marine resources might result in population-resource imbalances. The analysis of shell midden patterns conducted in this study provides no evidence of an increase of population, likely due to the small sample size of the data considered. If there was a substantial increase of population, it would produce more acute population-resource imbalances as the productivity of marine resources declined.

In general, people in the Pusan-Kimhae area intensified shellfish harvesting by increasing their use of less preferred, less easily procured species to overcome resource shortages. Some differences in the details of adaptive processes were noticed between sites. Whereas the Suga-ri and Pombang inhabitants tried to intensify shell fishing, the Tongsam-dong people reduced shellfish exploitation and shifted to the terrestrial-oriented strategy more rapidly. Since Tongsam-dong had a high dependence on marine resources, especially on marine mammals, it appears that environmental changes favouring more terrestrial habitats had more impact on the overall subsistence strategy here than at other sites. Therefore, the Tongsam-dong subsistence strategy was modified more drastically and rapidly by intensifying terrestrial resources to overcome the shortage of marine resources.

At Suga-ri, where no evidence of decreasing productivity of major species was detected, population increases or changes in subsistence scheduling appear to be the major causes behind the changing pattern. First, population-resource imbalance in the Suga-ri area could have been engendered by the movement of people toward inland areas, even if there was no overall population increase in the Pusan-Kimhae area. Second, the increasing use of terrestrial resources might change the overall subsistence scheduling and result in changes of shellfish gathering seasons. Even though short term adaptive processes or the pace of changes differed across sites, the overall subsistence in the Pusan-Kimhae area ultimately shifted to terrestrial resources by the end of the Late Chulmun period.

In the Kosong-T'ongyong area, the change from a marine to terrestrial-oriented subsistence strategy seems to have taken place very rapidly at the transitional period from Chulmun to Mumun. The exploitation of marine resources, especially fish and shellfish, was intensified by procuring more diverse species from more diverse habitats during the Middle and Late Chulmun periods. There is no clear evidence for the increasing use of terrestrial resources during these periods. The exploitation of marine resources was suddenly and drastically reduced during the Mumun period. Unlike the Pusan-Kimhae area, shellfish gathering did not entirely cease, but continued to be practiced on a small scale.

The Kosong-T'ongyong area experienced the same sea level decline from the late Middle Chulmun period as did the Pusan-Kimhae area. However, the productivity of major marine resources was not seriously affected by environmental changes. The productivity of shellfish remained high until the Late Chulmun period, as indicated by the relatively large size of shells. The increase in human population since the Middle Chulmun period suggested by the analysis of shell midden patterns could be the major cause for the changing strategies. As population in the area increased, the resulting population-resource imbalance necessitated changes in subsistence strategies.

While the Pusan-Kimhae area subsistence strategies changed with respect to short term intensification of shell fishing and increasing use of terrestrial resources, the Kosong-T'ongyong inhabitants actively intensified exploitation of marine resources. Most sites in this area were located on an open sea island remote from the mainland, and had more limited access to terrestrial resources than the Pusan-Kimhae area. There may have been certain limitations to expanding the terrestrial resource base. Therefore, the Kosong-T'ongyong inhabitants increased the exploitation of fishing and shell fishing based on their high productivity. This adaptive strategy seems to have been successful until the end of the Late Chulmun period, but resulted in the sudden decreasing use of marine resources during the Mumun period. It is highly possible that the overexploitation of marine resources took place after a long period of intensive use.

In summary, this study reveals that population-resource imbalances during the Late Chulmun periods produced by increasing population or decreasing productivity of marine resources could be one of the major contributing factors to the subsistence changes evident during the Chulmun period. The two research areas adopted different adaptive strategies to address the population-resource imbalance. The Pusan-Kimhae area gave up marine resources most rapidly and entirely shifted to terrestrial resources during the Late Chulmun period. The Kosong-T'ongyong area maintained marine-oriented subsistence until the end of the Late Chulmun period and shifted to the terrestrial-oriented strategy during the Mumun period. Why each area reacted differently in the process of subsistence changes is discussed below.

Discussion

From the results presented above, the dynamic, changing socioeconomic conditions of the Chulmun coastal foragers through time have been illuminated. Changes in environment appear to have fuelled the identified processes of socioeconomic transition. One of the major factors that allowed people to shift their subsistence to a terrestrial-oriented strategy was the cultivation of domesticated plants. The need to find an alternative procurement strategy initiated the use of domesticated plants in coastal areas, which was already practiced in farther inland regions adjacent to the study areas. This changing process of subsistence-settlement seems to be closely related to changing social and economic relations in the Late Chulmun society.

In order to understand the complex process of socioeconomic transition in the Late Chulmun society, three factors involved in this transition are examined here: (1) environmental/climatic changes, (2) population increase, and (3) increasing social complexity. The first two factors generate an imbalance between population and resources that drives people to pursue more intensive subsistence strategies (Price and Gebauer 1995). Increasing social complexity promotes the production of food surpluses for developing and maintaining differentiated social statuses (Bender 1978, 1981; Hayden 1990, 1992, 1995).

Population-Resource Imbalance

Data presented above reveal that the study areas experienced some degree of population-resource imbalance during the Late Chulmun period. This is reflected in the reduction in size of major shellfish species, the increasing use of less easily procured, less easily processed species, and/or the exploitation of marginal areas. The population-resource imbalance in each area was caused by either the decreasing productivity of marine resources or increasing population density, or perhaps both working in tandem.

Climatic/Environmental Changes

Paleoclimatic and paleoenvironmental research indicate that the Chulmun period was marked by continuous changes in environment generated by the changing climate and sea level (Ban and Kwak 1991; Ota, Umitsu and Matsushima 1990; Shimoyama 1991). Changes in environment do not always have an impact on human populations. It is evident that environmental changes resulted in a certain degree of resource stress in the Pusan-Kimhae area. In the Kosong-T'ongyong area, there is no substantial evidence to indicate any impact on resource availability due to environmental changes.

In the Pusan-Kimhae area, the sea level declined more than 1 m from the Middle to Late Chulmun period. The environment of the area became less favourable for the exploitation of marine resources. The productivity of marine mammals, fish, and shellfish whose habitat was primarily the subtidal zone was reduced. This decreasing productivity of marine resources resulted in a population-resource imbalance. This is evident in the reduction in size of major shellfish species, and the increasing use of less preferred, less easily procured species during the Late Chulmun period.

The Kosong-T'ongyong area experienced the same sea level decline as the Pusan-Kimhae area did. However, the productivity of major marine resources was not seriously affected by the changing sea level. The productivity of shellfish remained high until the Late Chulmun period, as seen in their large size. This is probably because the productivity of marine resources in this area was the higher of the two areas. Even though productivity decreased, the overall productivity was still relatively high when compared to other areas.

Changes in Population Structure

Using archaeological data to reconstruct changes in population structure is a complicated process. In this study, I examined changes in the frequency and size of shell midden sites to reveal any possible changes in population in the study areas. Increases in the frequency and size of shell middens could reflect an increasing intensity of shellfish exploitation, but not necessarily a population increase. Below, I consider whether there is evidence at each site for a population-resource imbalance that would indicate a substantial population increase.

For the Pusan-Kimhae area, the analysis of shell midden patterns provides no information about changes of population, due to the small sample size of the data. I propose that the movement of habitation sites into more inland regions during the Late Chulmun period could have produced an increase of population density in the inland areas, such as at the Suga-ri site. In the previous section, it was suggested that an imbalance developed between population and resources as the productivity of marine resources declined. If there were a substantial increase in population or an increasing population density in certain areas, this would produce more serious resource stress.

In the Kosong-T'ongyong area, the rapid increase in site frequency beginning in the Middle Chulmun period indicates that this area experienced an increase of population. As mentioned, this pattern could have resulted from increasing use of shellfish resources rather than from population increase. In this area, the increasing exploitation of less favoured and more cost-required habitats, including small islands and many outer coastal sites at farther distances, demonstrates that there was some resource stress in this area. Since there was no decrease in the marine resource productivity in this area, as suggested above, it seems probable that this resource stress was generated by population increase.

In summary, all areas show some evidence of population-resource imbalance during the late Middle and Late Chulmun periods. It seems most likely that the resource stress was generated by the combined effects of environmental changes and population increase, but that the relative importance of each factor differed among the areas. Current evidence shows that the population-resource imbalance was generated by sea level decline in the Pusan-Kimhae area, but by population increase in the Kosong-T'ongyong area. Population-resource imbalance caused by environmental changes and/or population increase could create important shifts in strategies for responding to stress. The use of domesticated plants could have been one of those new risk-reduction strategies. However, this may not have been the sole factor that promoted the transition to agriculture.

Social Demand

As evidence has accumulated, some changes in social structure during the Late Chulmun period can be clearly seen. The appearance of burials with some degree of status differentiation, the increase in long-distance exchange of raw materials, and evidence for craft specialization during the Late Chulmun period also indicate that substantial changes in social structure took place during this time.

At some sites in the Pusan-Kimhae area, such as Tongsam-dong, Suga-ri, and Pombang, a dramatic increase in the number of shell bracelets and the introduction of obsidian tools during the Late Chulmun period has been recorded (Ha, Lee, and Lee 1993; Jeong, Im, and Shin 1981; Sample 1974). At Tongsam-dong, more than 2,000 shell bracelets made of dog cockles (*Glycymeris albolineata*) were found. This is the second most abundant artefact, after pottery, at the site (Ha 1999; Kim, E. Y. 2001; Sample 1974, 90). A small number of shell bracelets are first seen during the Early Chulmun period. The number of bracelets gradually increased during the Middle Chulmun period, and drastically increased in the Late Chulmun period. More than half the shell bracelets reported from the site were found in Late Chulmun deposits.

Recently, several pieces of shell bracelets made from southern coast shells have been found in the Late Chulmun deposits at several inland sites, more than 150 km from the southern coast (Hong 1987; Son 1984b, 1997). Similar pieces are also found in large amounts in the Kyushu area of Japan (Aikens and Higuchi 1982; Imamura 1996a). It has been suggested that shell bracelets were an important trade items between the inland and coastal regions of southern Korea, and between southern Korea and Kyushu (Ha 2001a; Shin 1994; Son 1997). The increased occurrence of shell bracelets suggests the presence of more active long distance trade during the Late Chulmun period. The manufacturing process of shell bracelets has not been studied fully. However, it is highly possible that the production of these refined ornaments required some degree of specialization in tool making (Sample 1974, 90–92; also see Kenoyer 1983, 1985).

Obsidian tools were found in the Middle and Late Chulmun layers at Tongsam-dong (Ha 1999; Sample 1974) and the Late Chulmun deposit at Suga-ri (Jeong, Im, and Shin 1981). The provenance of these obsidian artefacts has been studied, but no conclusive results have yet been obtained. It has been suggested that obsidian used in southern Korean sites was from the Kyushu area of Japan or from northeastern Korea (Chi and Cho 1990; Ha 2001a; Han and Im 1993; Yi and Lee 1996).

Based on these lines of evidence, I propose that the Late Chulmun period was characterized by new forms of social and economic relations, such as the development of a long distance exchange system, emergence of specialized tool making, and the possession of valuables. These phenomena reflect changes in social structure during the Late Chulmun period in the Pusan-Kimhae area.

In the Kosong-T'ongyong area, we would expect to see increasing social complexity based on the successful adaptation to the rich marine ecosystem, combined with assumed sedentism. A variety of evidence from the Late Chulmun period reflects changes in social structure. Burials at the Yondae-do shell midden site, which have some evidence of differential burial goods, indicate the emergence of social inequality (Han and Im 1993). Shell bracelets from Yondae-do (Han and Im1993), Yokchi-do (Han, Kwon, and Im 1989), and Sandung (Kim and Park 1989), and obsidian tools from the Late Chulmun layers of Sangnodae-do Sang-ri (Son 1982), Yokchi-do (Han, Kwon, and Im 1989), and Yondae-do (Han and Im 1993) imply long distance trade and specialization in tool making.

Conclusion

In summary, the two study areas examined experienced some degree of resource stress during the late Middle and Late Chulmun periods as well as changes in social structure during the Late Chulmun period. Based on current evidence, I suggest that the subsistence change from a marine to terrestrial oriented strategy along with increasing use of cultivated plants was initiated by resource stress during the late Middle Chulmun period, but accelerated by social demands during the Late Chulmun period.

The Chulmun people in southeastern Korea appear to have been successful foragers. They exploited both marine and terrestrial resources according to seasonal cycles. They moved their habitation sites between coastal and inland areas on a seasonal basis. At some sites, long-term habitation and possibly a sedentary way of life can be posited. In their subsistence strategy, shellfish resources played a role as one of the major staple foods during the lean season, especially the early spring.

Changes in population structure and/or environment were among the conditions initiating the process of agricultural transition. Sea level declined more than 1 m from the late Middle Chulmun period resulting in a decrease in marine resource productivity. Not all areas were affected by this environmental change. However, molluscan and faunal data from some sites, especially in the Pusan-Kimhae area, show evidence of resource stress during this period. Based on a successful adaptation to the rich marine ecosystem and the assumed sedentary way of life, some areas like the Kosong-T'ongyong area likely experienced an increase in population. Intensive exploitation of marine resources during the Middle and Late Chulmun periods in this area indicates that people were under resource stress. The shift from a marine-oriented to a terrestrial-oriented subsistence strategy is observed from the Middle and Late Chulmun periods in the Pusan-Kimhae area, and from the Mumun period in the Kosong-T'ongyong area. People no longer seasonally moved between coastal and inland areas. They stayed more in the inland areas, and occasionally exploited coastal and marine resources.

One of the major factors that allowed people to shift their subsistence to a terrestrial-oriented strategy was the cultivation of domesticated plants. The need to find a different resource production strategy initiated the use of domesticated plants in coastal areas, which was already practiced in northern and central Korea, and possibly in farther-inland regions adjacent to the two study areas. During the Chulmun period, domesticated plants were used as a supplement to existing foodstuffs within a broad spectrum diet. The dietary role of early domesticated plants in the Chulmun foraging subsistence system remained a minor source of nutrition until the end of the Late Chulmun period in most parts of the two regions discussed here.

While cultivating domesticated plants, the Chulmun people increasingly appreciated the benefit of agriculture as a storable supplement that could support the accumulation of wealth, and gradually increased the use of cultivated plants. Social inequality had developed beginning in the Late Chulmun period in most parts of the study region. Emerging social inequality among these hunter-gatherers promoted increased production and exchange of rare prestige items, such as obsidian tools and shell bracelets. In the process of increasing social complexity, domesticated plants provided an excellent source of wealth accumulation. I propose that this is one of the major reasons why an agricultural economy gradually developed in the study areas during the Mumun period.

The model developed in this study emphasizes the complex and long term transition from foraging to agriculture. Complex cultural factors, such as the development of new subsistence strategies to overcome resource stress and the emergence of social complexity, worked together in the process of the transition. I propose that the subsistence change from a marine to a terrestrial-oriented strategy based on the introduction of cultivated plants was initiated by resource stress during the late Middle to Late Chulmun periods. The development of an agricultural economy was accelerated by social demands during the Late Chulmun and the Mumun periods in the Pusan-Kimhae and the Kosong-T'ongyong areas.

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June-Jeong Lee
Department of Archaeology and Art History
Seoul National University
Seoul 151–742
South Korea.
E-mail: junejlee@snu.ac.kr

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 80–89

7. The Implications of Inter-Group Food Exchange for Hunter-Gatherer Affluence and Complexity

Michael Jochim

The exchange of food among hunting and gathering groups is a common practice that has been implicated in the development of social complexity. Much of the literature, however, situates this practice and hence the development of complexity only in certain, restricted environmental contexts. It is argued here that (1) because food exchange occurs in a wide variety of contexts so too may the development of complexity and (2) in any context such exchange may not necessarily promote complex developments.

Exchange has occupied a prominent position in archaeological research, in large part because it often can be relatively easily identified through the distribution of material objects from obviously restricted sources. Obsidian and other stones and marine shells have received the greatest attention, with detailed analyses of chemical sourcing and distance-decay patterns (e.g., Bettinger 1982; Ericson 1977). The inter-group exchange of *food*, on the other hand, has received much less archaeological attention, due largely to its relative invisibility in the record. This is unfortunate, as food exchange has attracted considerable attention in the theoretical literature. In particular, food exchange has been viewed as intimately involved in the development of hunter-gatherer complexity, prompted usually by a need to buffer subsistence risks (Bettinger 1982; Halstead and O'Shea 1989; Rowley-Conwy and Zvelebil 1989) and manipulated by particular individuals for self-aggrandizement (Hayden 1990).

Certainly, the issues of hunter-gatherer affluence and complexity have been a major focus of attention for the past two decades (e.g., Price and Brown 1985; Rowley-Conwy 2001). Sahlins' (1968) characterization of hunter-gatherers as the "original affluent society" rested on a view of limited wants and needs leading to few material goods, high mobility, and egalitarian social relations. Subsequent discussions focused on the ethnographically documented deviations from this stereotype, on groups that were clearly more sedentary, owned more material possessions, and exhibited pronounced social inequality. Over the course of this time, a number of themes have gained much acceptance in the hunter-gatherer literature:

1. Living "hunter-gatherers" demonstrate so much variability that the term may have little value; about the only commonality is an economic base of non-domesticated food resources (Lee 1992).
2. Nevertheless, various features of different hunter-gatherer societies are highly correlated, allowing specific groups to be assigned to one of two largely dichotomous clusters of traits variously labelled "simple" vs. "complex" (Keeley 1988), "storers" vs. "non-storers" (Testart 1982), "immediate-return" vs. "delayed-return" (Woodburn 1980), or "sharers" vs. "aggrandizers" (Gould 1976). Although all authors recognize variability in these groupings and may emphasize a continuum between the two dichotomous extremes or may suggest more than two discrete categories, the strong patterns of correlation among different aspects of "complexity" are clear (e.g., Rowley-Conwy 2001, 44).
3. Both the environment and the organization of resource procurement are intimately related to the social organization of different groups. Dis-

agreements exist about the nature of these relationships and the extent of causality that can be inferred.

4. Intensified production of certain resources may be a key factor in the development of complex hunter-gatherer societies.
5. Intensification may be stimulated by different factors, including population growth and the need to increase food production, resource variability and the need for buffering through exchange or storage, social obligations and the need for alliances, or individual drives for prestige through feasting and redistribution.
6. As a consequence, exchange of intensified products, either to obtain resources in lean times, to maintain access to other groups' resources, or to build up debts and obligations among groups or individuals, may play an important role in the development of greater complexity. By "complexity" I refer here in particular to its social aspects: the degree of differentiation of roles, rights, and responsibilities and the degree of inequality in these characteristics (see Price and Brown 1985, 7–8).

The reasoning linking food exchange to social complexity usually posits one of two different scenarios. In the first, certain environmental contexts, particularly those with significant temporal variability and unpredictability in the abundance of critical resources, encourage the development of mechanisms to dampen the fluctuations and buffer the accompanying subsistence risks, when either the probability or the cost of failing to obtain adequate food resources is high (Bamforth and Bleed 1997; Halstead and O'Shea 1989). One of these mechanisms is exchange, which acts as a means of "social storage," creating reciprocal obligations among participants that can be called upon in times of need. Participation in such an exchange network requires the production of surplus to be given away, which in turn requires some degree of intensification – additional labour inputs into subsistence or manufacturing or new technologies of procurement – with the goal of increasing gross output. The organization of labour, the management of new technologies, and/or the supervision of the accumulation and distribution of the surplus may either encourage the development of managerial roles for efficient operation or allow individuals to achieve a disproportionate degree of authority in the processes and use this authority to their own social and material advantage.

The second scenario also emphasizes a particular environmental context, in this case one that contains resources, the production of which can be either intensified considerably or controlled. In this context, an assumed inherent drive to strive and excel leads some individuals to make available (through exclusive access to sources) or to produce surplus (through control of more labour) goods that are bestowed as gifts to others in order to impress and create reciprocal obligations.

In both scenarios, exchange, intensification, surplus, and social complexity are linked, but in different ways and in different environmental contexts. It is the intention here not to disagree with the above scenarios, but rather to augment them, to expand the contexts in which intensification may appear and at the same time to remove intensification from its monolithic role as a stimulus to complexity. Intensification may develop for reasons other than those cited above and it may result in changes to society other than those associated with greater complexity.

Types and Contexts of Exchange

All hunter-gatherers engage in some form of exchange, but the context and effects of this exchange can vary dramatically. At least three main forms of exchange may be distinguished according to their major effects and possible goals (Fig. 1):

1. Exchange may be a means of increasing subsistence *efficiency* by obtaining certain items at a lower cost than is true of local procurement or treks to sources. Although this is the type of mutualistic exchange most commonly discussed in the ethnographic literature, its importance has been relatively neglected in theoretical discussions in favour of other forms of exchange. There are, for instance, numerous examples among hunter-gatherers of western North America, often involving exchanges among upland and lowland groups or interior and coastal societies.

Among the Hupa of California, "[e]xchanges of commodities took place chiefly with the Yurok inhabiting the coast near the mouth of the Klamath. In return for dried seaweed, which yielded salt, surf fish, and other marine products, the Hupa supplied the coastal dwellers with acorns and additional inland foods. Considerably less trade was carried out with the riverine Yurok and Karok, because the products of these people were too much like those of the Hupa to allow for extensive bartering" (Wallace 1978a, 168). Similarly, Elmendorf (1992, 141) points out that among the Twana of Washington, "foods of different kinds, produced only in certain areas, were traded freely, giving each trader added variety of diet." The Tlingit of British Columbia, too, maintained exchange relations of this type: "The materials traded were the outcome of regional differentiation. The mainland villagers living in the river valleys were in a different ecological area than the villagers of the warmer, moister, and more heavily wooded islands…In the way of food, the mainland villages produced the highly prized eulachon oil, dried eulachon, and cranberries preserved in oil" (Oberg 1973, 107). Levy (1978, 411) puts it most succinctly for the Eastern Miwok of California: "The Eastern Miwok participated in a trade network that involved the flow of goods across ecological boundaries."

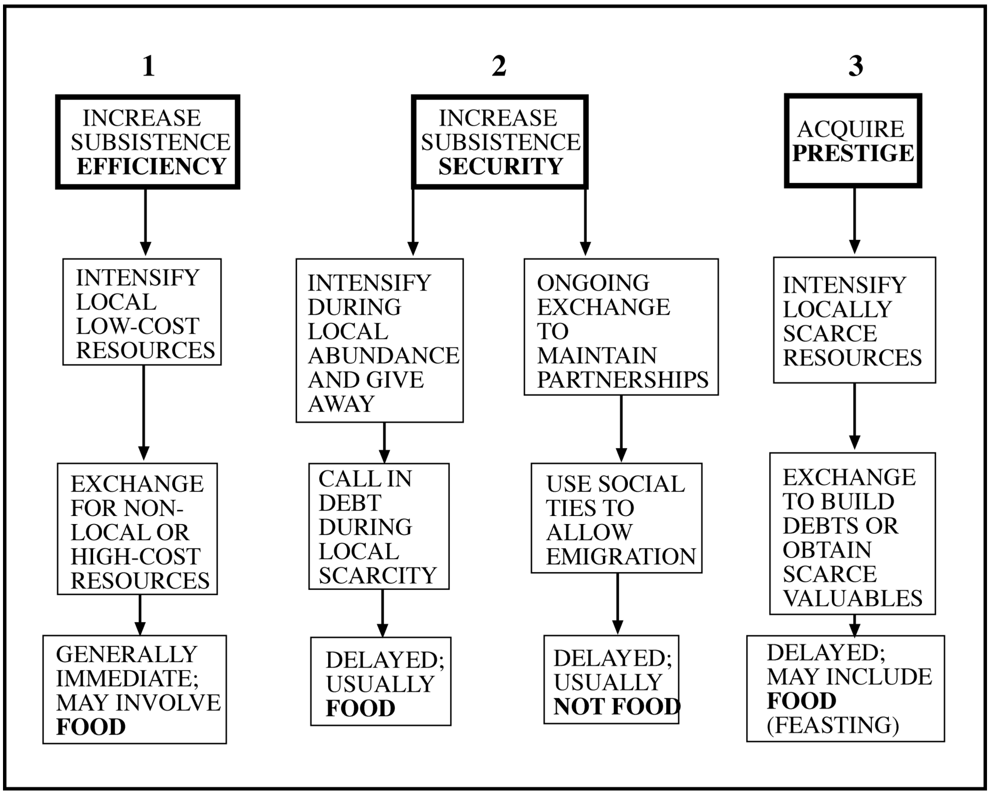
1
2
3
INCREASE SUBSISTENCE **EFFICIENCY**
INCREASE SUBSISTENCE **SECURITY**
ACQUIRE **PRESTIGE**
INTENSIFY LOCAL LOW-COST RESOURCES
INTENSIFY DURING LOCAL ABUNDANCE AND GIVE AWAY
ONGOING EXCHANGE TO MAINTAIN PARTNERSHIPS
INTENSIFY LOCALLY SCARCE RESOURCES
EXCHANGE FOR NON-LOCAL OR HIGH-COST RESOURCES
CALL IN DEBT DURING LOCAL SCARCITY
USE SOCIAL TIES TO ALLOW EMIGRATION
EXCHANGE TO BUILD DEBTS OR OBTAIN SCARCE VALUABLES
GENERALLY IMMEDIATE; MAY INVOLVE **FOOD**
DELAYED; USUALLY **FOOD**
DELAYED; USUALLY **NOT FOOD**
DELAYED; MAY INCLUDE **FOOD** (FEASTING)

Fig. 1. Simplified scheme of different types of hunter-gatherer exchange.

Fig. 2 – 4 illustrates some of the patterns in these exchanges that reflect largely movement of goods among different habitats (based on data from Davis 1961; Suttles 1990). In each case, the goods, such as acorns or eulachon, are either rare or absent in the recipients' territories and therefore would be difficult or expensive to procure directly. Among the Southern Valley Yokuts of California, "acorns, the standby of most California Indians, were not easily available. Each year the Tachi [one local subgroup] journeyed to the neighbourhood of Kingston to obtain their supply or traded fish for acorns with tribes to the east" (Wallace 1978b, 450).

Other cases of this type of transaction are the food exchanges between foragers and farmers in various regions of the world. In central Africa, parts of the Amazon Basin, and southeast Asia, hunter-gatherers such as the Mbuti, the Maku, and the Agta obtain carbohydrate-rich crops by exchanging meat and other products with farming groups, apparently as a way of supplementing a hunting diet more cheaply than would be possible by gathering wild plants. In one study, for example, the Efe of central Africa received 63.5% of their calories as crops from neighbouring farmers in exchange for meat, other forest products, and labour (Bailey and Peacock 1988, 101). As Peterson (1978, 337) states for the Agta of the Philippines, "foods provided by farmers are not necessarily preferred, they are simply easier to obtain and are a more dependable source of carbohydrates."

Foods are an important part of this type of exchange and the transactions are sometimes immediately reciprocal, although they may be organized at different levels of inclusiveness and may be secular or ritualized. In addition, individuals may manipulate such exchanges for other purposes, but the underlying contribution to subsistence efficiency remains.

2. Exchange may also be a means of increasing subsistence *security* by establishing social relations based on debts and obligations (Halstead and O'Shea 1989, 4; Spielmann 1986). This may take two different forms:

(a). One group may give away a surplus of a local resource to neighbours, with the understanding that these neighbours will reciprocate when they, in turn, have surplus resources. The trade feast among the Pomo of California is perhaps the best known example of this exchange system, in which periodic, local superabundances of fish, acorns, and seeds would be exchanged for shell beads, which could later be redeemed for other foods (Vayda 1967). A number of other groups in California practiced such exchanges (Bean 1978, 675), including the Owens Valley Paiute (Bettinger 1982). In this form of food exchange, reciprocity is delayed and a form of currency may be used to store value during this period.

(b). Another form of exchange related to economic security is exemplified by the *hxaro* system among the !Kung (Wiessner 1982). In this form, exchanges usually do not involve food, but rather craft items, which circulate

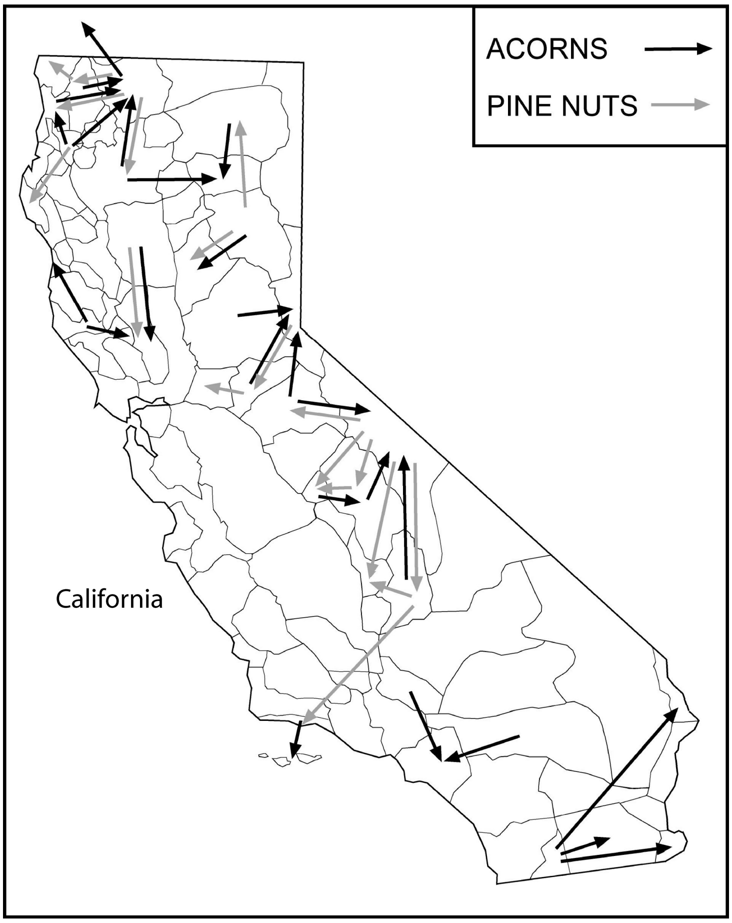

Fig. 2. Exchange transactions involving acorns and pine nuts in aboriginal California (after Davis 1961). Lighter lines represent ethnohistoric boundaries.

from participant to participant. Such exchanges are used to established partnerships that can be called upon to allow temporary immigration and access to partners' resources in lean times. The extensively documented exchange systems of Australia (Berndt 1951; Thomson 1949) and northern Alaska (Burch and Correll 1972) may have also served, in part, a similar function. This, too, is a delayed exchange, and although food does not directly change hands, the subsistence implications are clear.

3. Exchange can also be a means of asserting or increasing individual and/or group *prestige* by establishing access to or control over exotic materials. This form of exchange may involve food, particularly as feasting (Hayden 1990), and is usually a series of delayed exchanges both between and within groups. The Messenger Feast among the Eskimos of north Alaska provides one example. As described by Spencer (1959, 210), "the basis for the Messenger Feast was the enhancing of individual social status, or more specifically, the status of umealit, men who owned boats and headed whaling crews…Basically the feast lay in the invitation of the umealit of one community by those of another to attend and to engage in an economic exchange." The acquisition of prestige can also be linked to other forms of exchange in the management of risk-buffering trade feasts or of intergroup gatherings to exchange items from ecologically distinct areas.

All three forms of exchange can entail the movement of food, but the likely context for each is different. The first, acting to increase efficiency, occurs most often in areas of considerable environmental and cultural *spatial* diversity, where neighbouring groups have access to different resources. The great environmental diversity of California may in part explain the intense systems of exchange known ethnohistorically. The second form of exchange, serving to increase subsistence security, is more likely to occur in regions of considerable environmental *temporal* variability, coupled with *spatial* differences in the occurrence of shortages. The broader region, however, like the Kalahari or Owens Valley, may not show great differences in the kinds of resources available. For the third form of exchange, Hayden (1990) has argued that likely environments for this to persist contain particular

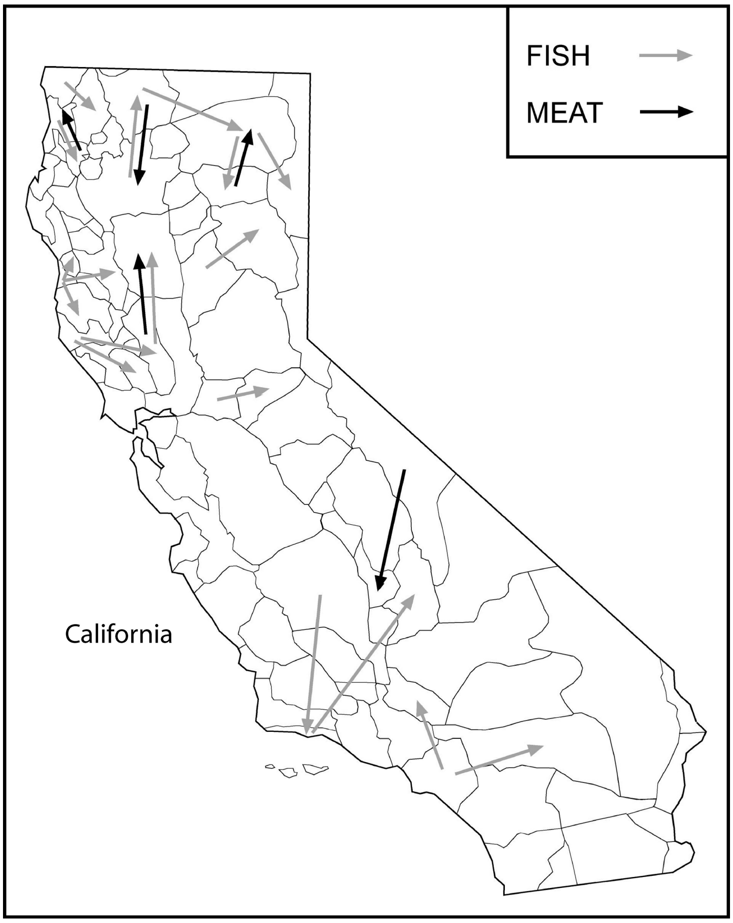

Fig. 3. Exchange transactions involving fish and mean in aboriginal California (after Davis 1961). Lighter lines represent ethnohistoric boundaries.

sorts of resources, ones like certain fish or seeds, the harvest of which can be intensified without depleting the stocks.

Exchange and Intensification

Given the wide variety of contexts and reasons for food exchange, it is reasonable to ask whether it inevitably leads to subsistence intensification in the form of additional labour. In discussing the mutualistic exchange relations between the Maku foragers and Tukanoan horticulturalists in the Amazon, Milton (1984, 20) argues that this is not the case: "Such cooperative behaviour widens the food web of each participant at no extra cost to either, since, in essence, each is trading surplus food for which they have no need and is receiving in return foods that are scarce." Bahuchet and Guillaume (1982, 198) suggest that the same was true of the pre-colonial exchange between the Aka and village farmers in central Africa: "Neither was there any noteworthy influence from the villagers on the types of hunting practiced. It was more a question of Aka exchanging surplus food products after their own consumption needs had been met." In some (perhaps many) situations, therefore, exchange was based on the normal, periodic surpluses generated by hunting, rather than on any purposeful surplus production. Hunting returns often show great variability from day to day, and unanticipated surpluses can occur with some frequency. Bailey and Peacock (1988, 105), for example, witnessed such events among the Efe of central Africa: "Twice during the study we were present in a camp when an okapi was killed. On the first occasion approximately 110 kg of meat were brought into a camp of 20 people; on the second occasion 170 kg of meat were shared among 21 people."

In other situations, however, mutualistic food exchange does, indeed, appear to have promoted an intensification of effort to produce a surplus. This is suggested first of all by the large amounts of food sometimes exchanged. In one study of the Agta of the Philippines, for example, these foragers traded more than 50% of the deer they killed to neighbouring Palanan agriculturalists (Peterson 1978, 341). In a record of 54

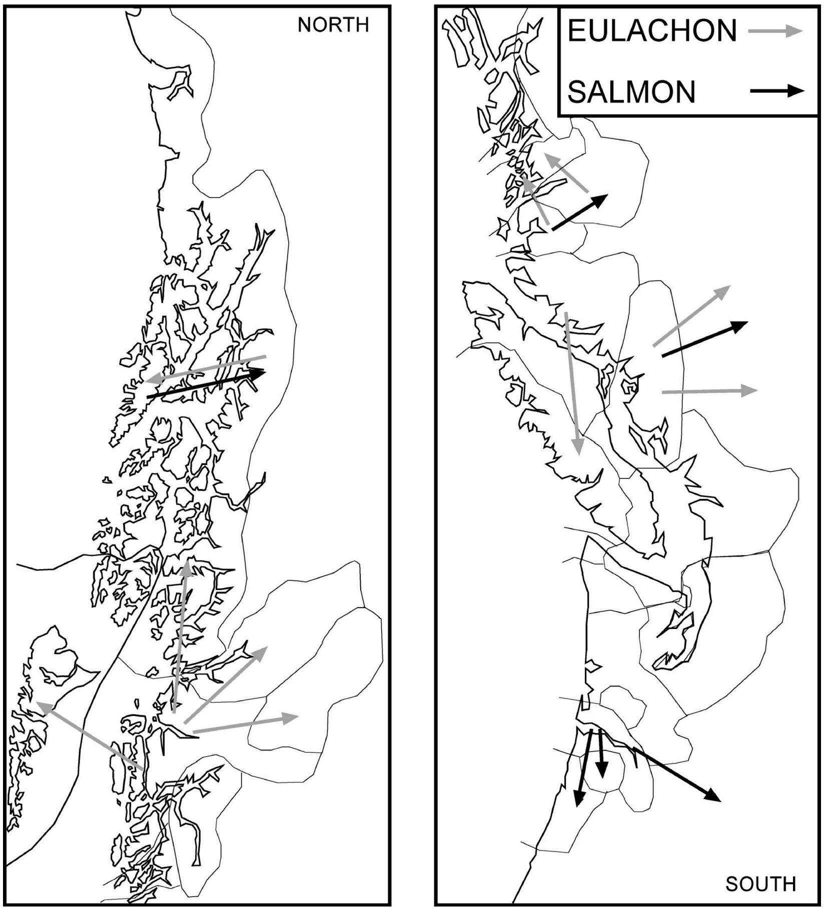

Fig. 4. Exchange transactions involving eulachon and salmon among aboriginal societies of the Northwest Coast (after Suttles 1990). Lighter lines represent ethnohistoric boundaries.

days of hunting by the Maku, over 100 kg of mammal meat was obtained, of which roughly 36 kg, or 35%, was traded to the Tukanoan horticulturalists (Milton 1984, 25–27). Quantitative records for the Efe indicate that only 14% of the meat they acquired during the study period was traded to the Walese, but for this group food was secondary to labour as an exchange good (Bailey and Peacock 1988, 109).

More direct evidence of intensification of effort specifically to generate a surplus for exchange is difficult to obtain, given the paucity of long-term, quantitative studies, as well as the lack of baseline data reflecting activity levels in the absence of exchange. Nevertheless, there are hints that this kind of mutualistic exchange did influence time allocation by the participants. The present-day Aka "maintain forest activities which are nonetheless conditioned by their neighbours. Much hunting time is devoted to producing game for the 'masters'" (Bahuchet and Guillaume 1982, 206). The Palanan partners of the Agta regularly planted "10% to 30% in excess of their own consumption needs in anticipation of Agta requests for trade" (Peterson 1978, 342), raising the possibility that the Agta, in turn, may have intensified their hunting efforts. Discussions of the trade in eulachon oil by the Tlingit emphasize the large amounts produced, roughly 40 to 72 gallons of oil per man (Krause 1956, 122), and the effort underlying this production: "In May, fishing again became important, for in this month the oil-producing fish are caught. In this period, fishing is very intense and almost all other activities cease for about two weeks…." (Oberg 1973, 73).

Another indication of intensification is a change in technology. The Aka provide one example (Bahuchet and Guillaume 1982, 199-202). Originally, hunting was practiced primarily with bow and arrow. With the development of the ivory trade at the beginning of the 20th century, the Aka began to give greater emphasis to both spear-hunting expeditions and hunting with newly acquired guns, techniques that were more suited to elephant hunting but which also provided larger quantities of meat than previously. With the decline of elephant populations and the ivory trade and the rise of rubber extraction, Aka hunters increasingly adopted net hunting as a way of providing large and regular quantities of meat to the workers. There is, consequently, a good deal of evidence suggesting that mutualistic exchange, serving especially to enhance subsistence efficiency, can promote subsistence intensification in some situations.

There is evidence that risk-buffering exchange also encouraged intensified food procurement, as has been assumed. In one instance of a trade feast among the Pomo, the "Lake chiefs freely fed the Yokaia visitors during their stay, apparently from stores that had been assembled especially for the occasion" (Vayda 1967, 497). The !Kung *hxaro* promotes intensification of effort as well: "Many hours are put into maintaining critical social relations. Participating adequately in hxaro involves taking the time to make or remake gifts (some pieces of beadwork take three to seven days of concentrated work), gathering information about who has and who is in need, and finally making sure that one gets one's fair share of goods and resources" (Wiessner 1982, 79).

Exchange as a vehicle for acquiring prestige can clearly entail substantial intensification of effort. In discussing competitive feast among "accumulators," Hayden (1990, 36) states, "one of the most important characteristics of these feasts is that highly desirable, rare, valuable, and often labour intensive foods or delicacies (too effort demanding for daily consumption) are employed to impress guest competitors with the host's wealth and power…." For example, in preparing for a Messenger Feast in north Alaska, "not only was food amassed in quantity, but also were clothing, skins, pokes of oil, kayaks and umiaks, sleds, dogs, and the like" (Spencer 1959, 212).

Resource Intensification and its Effects

Hayden (1981) draws attention to an important ecological distinction among resources according to their potential for intensification. So-called "K-selected" species, such as most larger mammals, are slow growing and produce relatively few offspring. Intensification of their use could easily and rapidly lead to local depletion. By contrast, "r-selected" resources, which include many seeds, nuts, and fish such as salmon, grow quickly and reproduce abundantly, with the result that intensified human use rarely has a strong impact on the resource populations.

Intensification may be applied to any type of resource, but with differing effects, not only on the resources themselves, but also on many aspects of the human groups. The intensification of salmon by aboriginal peoples of the north Pacific coast may have had relatively little effect on the fish populations, but doubtless had an impact on human society. Schalk (1978), for example, discusses how the intensification of salmon fisheries may have contributed to:

1. Greater sedentism
2. A shift in settlement location to prime fishing spots
3. The elaboration of procurement and processing technology
4. The development of storage technology
5. A greater complexity of labour organization
6. More centralized control within productive units
7. Greater specialization of labour
8. More numerous social distinctions, and
9. Greater rigidity of group structure.

Obviously, all of these characteristics are typical of many of the ethnohistorically known complex groups along the Northwest Coast and all probably derive from a number of factors in addition to intensified fishing, but the role of intensification and exchange cannot be denied. These changes, moreover, are in line with the postulated link between intensification and social complexity.

By contrast, both the Mbuti and Aka of central Africa exchange meat and other forest products originally with local farmers, but increasingly with commercial meat traders. Their major prey, duikers, belong to the category of relatively "K-selected" resources, and their populations have suffered as a consequence of the intensification of hunting for exchange. Hart (1978) documents that hunting yields among the Mbuti groups he studied were very low in areas close to villages, where hunting pressure had been most intense, in comparison to regions farther away. Moreover, hunting returns in one area declined by 32% over a three-year period of intensified hunting. As a result, although hunting of these animals was intensified in response to the stimulus of food exchange, it is unclear how long this could be continued.

In addition to these effects on the duiker populations, Hart (1978) documented a number of other changes in labour and settlement organization among the Mbuti (Fig. 5). These include:

1. A greater frequency of hunts
2. Greater time spent per hunt
3. A greater number of net casts per hunt
4. The use of a greater proportion of the available nets in camp
5. A shift of hunting camps to areas farther from the residential camp
6. More frequent moves
7. Longer moves between camps
8. Less frequent reoccupation of campsites
9. Increased competition for resource areas, and
10. Greater tensions within camps.

To these may be added observations made among the Aka (Bahuchet and Guillaume 1982), where the intensification of hunting for trade led to:

11. A technological shift to a greater use of nets rather than spears
12. A growth in average camp size to provide more labour for net hunting

EFFECTS ON LABOUR

TRADERS	HUNTS/WEEK	% NETS USED	HOURS/HUNT
ABSENT	4.1	71%	5.4
PRESENT	5.9	85%	6.9

EFFECTS ON SETTLEMENT

BAND	% CAMPS WITH TRADE CONTACT	% CAMPS REOCCUPIED	AVERAGE CAMP OCCUPATION	AVERAGE MOVE
A	6%	44%	3.1 weeks	4.4 km
B	93%	14%	2.1 weeks	6.6 km

Fig. 5. Effects of Aka commercial meat trade (after Hart 1978).

In both the north Pacific and central Africa, intensified resource procurement had significant effects on technology, settlement, and social organization, however these effects differed in part according to the nature of the resources. The Pygmy groups became more mobile, relied little on storage, and remained essentially egalitarian; it is clear that intensification does not necessarily lead to the development of complex hunter-gatherers.

One might argue from these two examples that the intensification of r-selected resources leads to sedentism and social complexity, whereas the intensification of K-selected resources promotes greater mobility and equality. I suspect, however, that the issue is not so simple. The resource dichotomy is a useful heuristic, but like so many dichotomies, it masks considerable variability. Resources are not *either* r-selected *or* K-selected, not quickly depleted *or* inexhaustible. Their response to intensified exploitation depends on a number of factors, including their intrinsic reproductive capacity, their initial abundance, the amount of labour applied to their exploitation, and the nature of the extractive technology. Consequently, the potential for intensified production should be variable as well. Some animal populations may be much more rapidly depleted than others. Some fish populations may be quickly overexploited, whereas others may be constantly renewed. Different species of seeds and nuts can vary in their spatial ubiquity and cycles of productivity. Depending on the local resources and their characteristics, together with features of the exploiting group, there may be diverse outcomes of processes of intensification. The intensified exploitation of resources need not lead unvaryingly to rapid depletion *or* social complexity.

If we are to understand hunter-gatherer organization, both economic and social, we clearly need to look beyond the local ecology and the internal social dynamics. Interactions with neighbours can take a variety of forms and have a myriad of effects. All types of exchange can stimulate intensification and redirect production with variable ramifications for technology, settlement, and social organization. In some cases these take the form recognized as characteristic of complex hunter-gatherers; in others they might lead to more mobile, egalitarian foragers attempting to intensify a fragile resource base. The historic groups of the Great Plains, many of whom intensified bison hunting and carried out exchange with neighbouring horticulturalists, appear to represent yet another possibility, one in which some degree of social complexity is combined with high mobility (Bamforth 1988; Spielmann 1983). Exchange may be encouraged by resource variability, but it might also represent an efficient means of satisfying wants or needs. In either case, it might also be used by aggrandizing individuals, but if resource depletion ensues, this is unlikely to lead to further social changes.

Archaeological Visibility

In light of the important theoretical role played by intensified food production and exchange in the theoretical literature, it deserves more concentrated archaeological attention. From the foregoing discussion it seems clear that *indirect* evidence in the form of increases in sedentism or other signs of complexity will not do as archaeological indicators. Not only are they simply the hypothesized effects of such exchange, but they may not be the only such effects, as suggested by the African examples. Rather *direct* evidence of intensification and exchange must be sought (see, for example, Friesen 2001; Hayden 1990; Pauketat et al. 2002; Potter 2000), including:

1. Procurement technology, indicative of more specialized tools or devices facilitating mass harvesting
2. Age-sex profiles of animal prey, suggesting more communal harvesting

3. Prey diversity, indicating more focused procurement
4. Animal body part representation, demonstrating the regular absence of certain parts given away or certain parts selected for drying
5. Site location, suggesting a shift to particular resource areas
6. Storage facilities in the form of pits or posthole arrangements, reflecting the production and at least temporary storage of surplus
7. Feasting, as represented by discard accumulations of relatively homogeneous faunal remains showing less processing or selected body parts, concentrations of such remains in restricted site areas, and their association with other rare or costly foods, valuables and magico-religious paraphernalia

Conclusion

Hunter-gatherers are not social isolates. They interact with neighbours in various ways, with possibly profound effects on all aspects of life. The theoretical literature has given increasing emphasis to the role of such interaction in social change, but has devoted most attention to the causal relations between exchange and the development of complexity, ignoring other sorts of transformations. In addition, archaeological studies have focused especially on the evidence for exchange of non-food items. If we are to understand the variations in hunter-gatherer organization, we must expand our understanding of the *various* relationships between exchange and patterns of technology, settlement and social organization, and develop more precise tools to monitor the role of *food* exchange in the past.

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Michael Jochim
Department of Anthropology,
University of California, Santa Barbara
Santa Barbara,
CA 93106–3210, USA
E-mail: jochim@anth.ucsb.edu

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 90–105

8. Last Foragers in Coastal Environments: A Comparative Study of the Cantabrian Mesolithic, Yamana of Tierra del Fuego and Archaic Foragers of the Central American Coast

Ermengol Gassiot Ballbè and Jordi Estévez Escalera

In recent years coastal foragers have emerged as a recurrent topic in discussions of explanatory models for complexity. These discussions have generally emphasized the concept of "affluent foragers", where complex coastal cultures arose because of abundant and attractive littoral resources. An alternative perspective sees the colonisation of coastal areas and consumption of littoral resources as an intensification process caused by demographic pressure and a decrease in terrestrial collecting and hunting productivity. In this paper we present the results of many years of archaeozoological and ethnoarchaeological research in three different contexts where forager societies exploited littoral and marine fauna to various degrees. The analysis of food production through vertebrate and invertebrate fauna consumption allows an evaluation of the economic foundations of coastal hunter-gatherer societies. The comparative study of three geographically disparate situations allows for the dismissal of strict environmental causality as a primary explanation for the development of coastal adaptations. More satisfying explanatory models are proposed that consider both the economic and social characteristics of these coastal hunter-gatherers, and the broader problem of their evolutionary change to domestication economies is addressed for cases where this transition occurred.

Introduction

After a history of neglect the study of littoral adaptations among hunter-gatherer societies has become a recurrent topic of archaeological discussion over the past 25 years. This new focus produced the realization that the exploitation of littoral and marine resources by foraging communities became widespread only at the beginning of the Holocene. To explain the change in theoretical perspective on the importance of littoral hunter-gatherers it is necessary to refer to a variety of trends in archaeology that are difficult to summarise in only a few words. Having said that, and at the risk of oversimplifying the issue, three main causal factors can be identified that are to a great extent linked to transformations that brought about processual explanations in our discipline.

First, the definition of culture as adaptation focused attention in the 1970s and 1980s on the impact that ecological factors have on social behaviour. For many scholars, the limited technological development of hunter-gatherer societies meant that they were even more at the mercy of the environment. This was a continuation of the theses defended by scholars such as Leslie White and Julian Steward. Binford's (1980) classic division between foragers and collectors and Jochim's (1976) work provide more recent examples of this vein of thought. In this tradition, marine and littoral environments, which were markedly different from an ecological point of view from those found inland, were treated as distinct contexts that had a very specific effect on the foraging communities that inhabited them (Perlman 1985; Hassan 1981). A related question was why these environments were colonised in the first place. For some authors, littoral areas were marginal environments and their settlement by human groups was driven by imperatives, such as those resulting from demographic pressure upon more favoured ecological niches (Cohen 1977; Osborn 1977).

Other authors considered coastal environments to be extremely rich in terms of biomass and therefore believed their settlement to be due to their economic attractiveness (Birdsell 1968, Perlman 1980, Sauer 1962, Yesner 1980). These disparate views generated productivity studies of different ecosystems, the demographic dynamics of pre-agricultural groups, and the capacity of these groups to respond to a variety of internal and external pressures.

Renewed interest in paleoeconomics within archaeology is a second factor, and this development is partly interrelated with the first. If pre-industrial groups are mainly adaptations to ecological circumstances, it is then necessary to understand how different cultural options provided solutions to these pressures. In this regard, the English tradition of archaeology begun by G. Clark focused much attention on pre-Neolithic littoral adaptations in some areas such as the north of the Iberian Peninsula (Bailey 1978). The application of the economic theory of diminishing returns by Boserup (1965) opened another line of research linked with the belief that coastal environments were marginal areas. Other work (Earle and Christenson 1980) developed these propositions with premises similar to Cohen's (1977), which easily dovetailed with proponents of the Optimal Foraging Theory (Smith 1983; Winterhalder and Smith 1981). More recent work from this perspective situates the exploitation of marine and littoral fauna within the framework of a progressive drift towards a diet of low-value resources. This drift would have been the result of the evolutionary pressures faced by hunter-gatherer groups: demographic growth, geographical circumscription, technological development, and increased competition (Broughton 1994, 2002; Hayden 1981, 1994). In some cases these pressures were produced by environmental changes, such as the post-Pleistocene marine transgression. This view also coincides with theories about the importance of demographic pressure caused by the reduction of available land, which is used to explain the drift towards farming communities (Binford 1968).

Third, with the studies of the !Kung and Hadza, among others, at the end of the 1960, ethnographic studies provided archaeology with the inspiration to learn about different aspects of the social behaviour of foraging societies. These studies supplied the necessary quantitative base for the development of many archaeological models (e.g., in the calculation of labour time, duration of settlements, etc.). Nevertheless, the increased familiarity of archaeologists with ethnographic sources, particularly the affluent societies of Northwest America, started a debate about the levels of social inequality associated with this kind of society and the supposed universality of "primitive communism". The work of Price and Brown (1985), Bonsall (1989), and Testart (1982) was the starting point for the study of the complexity among hunter-gatherer societies. Much of the evidence for social complexity appears in the Holocene within the context of groups settled on the coast and whose economies were to a greater or lesser extent oriented towards coastal and aquatic resources. This observation brought together the study of the last manifestations of hunter-gatherers, analysis of the exploitation of littoral resources by foraging communities, and social complexity in pre-agricultural contexts.

In this paper, we adopt a cross-cultural perspective by examining diverse cases of post-Pleistocene hunter-gatherer groups that exploited coastal areas (Fig. 1). We first present the results of research in Tierra del Fuego, where groups of canoeists subsisted for 6000 years up to the beginning of the twentieth century. Second, we look at the latest research into the last foraging groups of the north of the Iberian Peninsula and their relationship with Neolithization processes. Finally, we present data that permits us to sketch a preliminary outline of the end of foraging economies of the Caribbean coast of Central America and the incipient cultivation of specific plants. In all cases the way in which production was organised decisively affected the evolutionary trajectories that emerged within these societies. We present three case studies to demonstrate that environmental relationships are incapable of providing a satisfying explanation for the way in which various littoral foragers organized themselves. Elsewhere we have made extensive analyses of the hunter-gatherer mode of production (Estévez et al. 1998; Estévez and Vila 1998; Gassiot 2000, 2002a). Here, it will suffice to state that we assume hunter-gatherer societies exist in a changing context that is the product of their own contradictions and internal tensions, and that these tensions are fundamentally of a social origin. In other words, despite the fact that ecological factors derived from the type of biomass available from the environment may play a role in shaping change in a society, the origin of organisational shifts should be sought in the different methods of production of the means of subsistence and, above all else, in the social relationships that are generated as a result. In the last part of the paper, this perspective serves as a base to synthesise a number of regularities associated with the economic exploitation of littoral environments in different geographical and climatic contexts. The identification of shared factors allows us to look for causalities of a social nature in the production sphere.

Tierra de Fuego: A Long Unbroken Stability and a Tragic End

The shellfish gathering, fishing and hunting society of Tierra del Fuego at the southernmost tip of the South American continent is the subject of our first study. Interest in these hunter-fisher-gatherer societies is paradigmatically linked with the formation of Western ethnographic thought. The influence of these societies on the development of evolutionary thought following Darwin's voyage on the Beagle is undeniable, and they

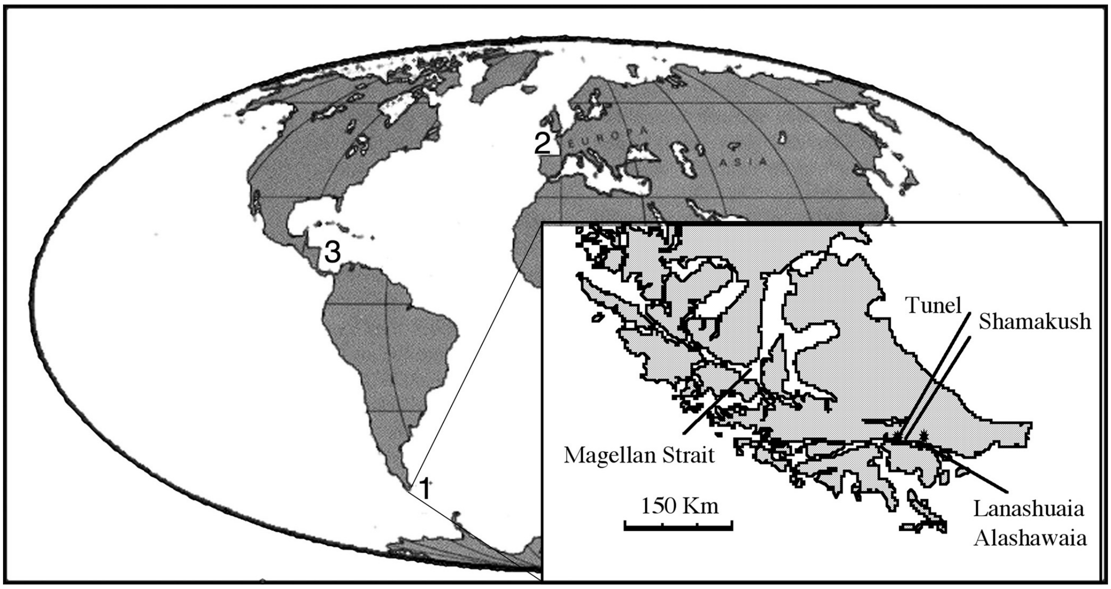

Fig. 1. Map of the geographical location of the three cases studied: (1) Tierra del Fuego, (2) Cantabria, and (3) Caribbean. Inset: detail of the excavated sites on the northern side of Beagle Channel.

have been the object of archaeological studies since 1932 (Bird 1938, 1988). The archipelago was certainly colonised by pedestrian hunters before 9700 cal BC prior to the flooding of the Magellan Strait, and then again after 5750 cal BC by groups of people who exploited land and littoral resources simultaneously. However, from at least 5150 cal BC onwards settlers on the southern coast were exploiting marine resources and must already have had some form of marine transport, as they would have had to cross a series of channels to reach sites discovered on the islands of Magellan and Navarino (dated to around the year 5100 cal BC)(Legoupil 1994; Orquera and Piana 1999; San Román et al. 2002).

Before 4400 cal BC forest vegetation of *Nothofagus* sp. (South American Beech) similar to that which exists today had spread along the coastline of the Beagle Channel. The average temperature of the water of the Channel has not varied by more than 2ºC between the Climatic Optimum (between 4900 and 3200 cal BC) and short cold spells (around 1800 cal BC and the Little Ice Age of modern times) (Obelic et al. 1999). Despite minor changes in the environment, there was general stability in the nature of resources and their availability. Resources are distributed fairly homogeneously in the territory, and although they undergo slight variations over the course of a year (e.g., upward seasonal mobility of guanacos, entry of fish into the channels and breeding of birds and pinnipeds in the summer) there are no periods of seasonal shortage that would require significant migrations of people to access resources. Our general point is that any overexploitation and depletion of local resources such as molluscs, fish, birds and firewood (Piqué 1999) could be solved by moving residence to a not-too-distant place with similar resources and/or by the dispersal of social units (which were highly mobile due to the use of canoes). Overall, these societies lived in a relatively stable environment throughout the chronological sequence considered here.

Excavated Sites

It has been possible to chart the settlement sequence of the region (Orquera and Piana 1999) from extensive excavation at nine sites, information from extensive survey, dates from 100 sites, and the isotopic profile of paleotemperatures (Vila et al. 1998; Estévez et al. 2001). This shellfish gathering, fishing and hunting society has been variously described as an adaptive cultural tradition (Piana 1984), a successful and sustained adaptation to a coastal area, or as a successful adaptation to an adverse environment (Orquera and Piana 1999). The largest input of calories came from the exploitation of marine mammals (hunting of pinnipeds and, occasionally, scavenging stranded whales), although the greatest effort and contribution to day-to-day subsistence was through shellfish gathering and fishing (Estévez and Martínez 1998; Estévez and Vila 1995). This diet was complemented with the hunting of guanaco (*Lama guanicoe*), sea otter, birds (especially seabirds such as cormorants and penguins), and the gathering of crustaceans as well as some fruits and mushrooms.

If we consider the tool set used, we may postulate a form of specialisation in the exploitation of marine resources. As evidence for this, we highlight the investment of labour necessary for the construction of bark canoes and their accessories, as well as in the tools needed to obtain marine resources from canoes, such as harpoons and polished weights. All of these reflect the importance of these food sources. This pattern of littoral specialisation has been described (Orquera and Piana 1999) as a forager system (*sensu* Binford 1980) incorporating a certain degree of flexibility and some collector features such as the ethnographically described hunting of guanacos by teams of men. But despite the overall stability observed in strategies for the exploitation of resources some changes did occur. These changes were virtually independent of changes in the environment and there is no real correlation between changes in technology and in the resources exploited.

Changes over Time

The oldest known settlement on the north coast of the Beagle Channel is the lower level of the Tunel I site, which is dated at between 5850 and 5600 cal BC. It reveals a short atypical episode of occupation during which intensive exploitation of littoral resources is not evident. A short time later, an occupation level at the Imiwaia site (between 4800 and 4300 cal BC) and a later level at the Tunel I site (5150 cal BC) yielded artefacts related to the exploitation of littoral resources with clear signs of intensive fishing and the exploitation of molluscs present. Despite environmental stability and a general continuity in strategies of exploitation of marine resources over five millennia of occupation, one observes changes in the tools set that reveal processes of readjustment and a series of tensions in the technological and social system. Between 5150 and 4700 cal BC the first polished fishing weights appear, although polishing has been documented dating from the first occupation of Tunel I.

A new and important change is documented at the Lancha Packewaia site in the levels that correspond to 2500 cal BC. Here, a series of crudely made bifacial points and non-local raw material characterize the production of tools. Harpoons, however, continue to have the same shape as at older sites, though no decorated specimens like those seen earlier have been discovered. Finally, another important change takes place around 900 cal BC at the Tunel I site, In the fourth component there appear what can be interpreted as the first arrow points. With this technological addition almost entire the tool set documented ethnographically was present. In later periods, harpoons were simple in shape and carved decoration disappeared from bone objects.

With the arrival of Europeans in the seventeenth and eighteenth centuries, exogenous raw materials start to be used. Metal and glass substitute for autochthonous raw materials (stone points, bone awls, and knife blades made from mollusc shells). This shift has been documented at the Lanashuaia and Tunel VII sites. The adoption of European materials was sudden and surprising. Indigenous people were very quick to appreciate the superior qualities of these new materials in tasks that had formerly been done inefficiently by local materials, which were less effective, less durable, more likely to break in use, or, in the case of flaked tools such as bifacial arrow points, more difficult to manufacture due to the unpredictable fracturing patterns of the material.

On the other hand, it is very likely that an ideological component would also have influenced decisions concerning raw material use. The new materials were not only more useful, but foreign. Possession must have distinguished the owner, as the accessibility of exogenous materials was restricted. The new materials were immediately incorporated into systems of exchange and social interaction. It is interesting to note how they were used to process larger animals that were distributed amongst various social units. It is possible that the added value of exotic materials acted as an indicator of the latent social inequalities between the two sexes within Yamana society (Vila and Ruiz 2001). Changes in tools may also have led to changes in the kind of objects being produced. In this respect, it would be useful to investigate whether the replacement of bark canoes by wooden plank or tree trunk canoes and the construction of conical huts to replace hemispherical huts made from branches was related to the introduction of European metal axes. The same could be said for ethnographic period harpoons, which are much bigger than any that have been unearthed archaeologically, and of the presence among northern canoeists of double-toothed harpoons that require more effort to produce (which have yet to be recovered in pre-contact archaeological sites.

Discussion

If the same tool set as that of Fuegian canoe peoples were found in any other archaeological complex, in all probability it would lead to the conclusion that such a society was specialised in the exploitation of marine resources. Variations in the resources exploited in different areas could be seen as due to changes brought about by climatic oscillations. However, careful analysis of resource management systems over the period of a century at Tunel VII and Lanashuaia, sites which date from the ethnographic period, show that fine adjustments were made to conditions dictated by the ecological microdiversity, and that there was an opportunistic attitude in the utilisation of what was available at specific times and places (Estévez et al. 2001). At the Tunel VII site, ten consecutive occupations in the same spot would seem to indicate that it is more accurate to call this strategy “non-specialised specialisation”. Each occupation reveals differences in the kind of birds hunted and fish species caught. We can therefore state that, over a short period of time, the people adopted a wide variety of strategies to adjust to small environmental variations in space and time. In short, within a general orientation towards the hunting of pinnipeds with harpoons, fishing from canoes, coastal gathering of molluscs, and the hunting with bow and arrow of guanacos in winter by small teams of men, they otherwise took advantage of whatever was available. Tools were also opportunistically used. Although the most suitable weapon for the hunting of pinnipeds was the harpoon, they were also hunted from land with bow and arrow, probably as a result of casual and likely relatively frequent encounters.

Even the most important social happening was the result of chance (at least in the ethnographic period). Stranded whales provided an opportunity for several autonomous family units to meet and these occasions brought into play the few strategies used to preserve food (e.g., whale meat deposited in peat bogs). These activities also produced the most intense periods of social interaction. To sum up, there is no rigid barrier between logistical strategies (putting to sea in canoes to harpoon pinnipeds, raids on the nesting sites of birds, or expeditions to hunt guanacos in small teams) and opportunistic strategies. This kind of specialisation does not imply inflexible strategies.

The End of the System

The most interesting question concerns the continuity and maintenance of the system. It has been said that the constant flow of biomass from the Antarctic confluence and the inaccessibility of the breeding grounds of pinnipeds created a supply of resources that was barely affected by human exploitation (Schiavini 1993). However, population density – there was a population of between 2500 and 3000 people for the littoral area south of the Beagle Channel at the time of contact with Europeans – was high compared with other hunter-gatherer societies. An approximate calculation suggests that this population had stabilised near the maximum extractive capacity of the Yamana economic and social organisation. A population growth model that begins 6000 years ago and ends in a final total population of 3000 people requires a growth rate way below normal human capacity. This phenomenon can best be explained by the existence of a strict control on reproduction. It is very difficult, although it is not impossible, to demonstrate archaeologically that imbalances between biological and social reproduction were transmitted to production strategies. The changes observed in technological development that were mainly designed to reduce costs, including the styling of harpoons or increasing the range and effectiveness of weapons (e.g., arrow points replace the larger points of spears and javelins, metals and glass replace stone and bone raw materials very quickly), may have been stimulated by these contradictions.

The technological changes were a way to resolve the contradiction between the growing social needs of food and the acquisition of subsistence by reducing the cost of labour invested in food procuring in a context where the renewal or replacement of natural resources is biologically limited. Processes of population control such as periods of death from starvation, stress or even through infanticide are difficult to detect, although infants have been found buried in shell middens at a significant number of sites between 50 cal BC and 400 cal BC. Changes in the internal arrangement of habitation units in the Beagle area have been documented throughout the sequence (Orquera and Piana 1999). Ideology must also have undergone changes in order to control population growth. Although we still do not have enough data for the southern area before the ethnographic period, in the northernmost area of Magellan (which was osmotically linked to the southern area as shown by sites excavated to the north of the Strait of Magellan [Legoupil 1985-1986]) a number of significant changes in funerary practices have been identified (Prieto 1984). It must have turned out to be more economical to establish an asymmetrical system with reproductive control over women like the one that has been documented ethnographically, instead of developing new means of production and work organisation that would have permitted a substantial increase in the extractive capacity.

These social controls and restrictions on reproduction (Vila and Ruiz 2001) were maintained despite the diseases introduced by European visitors from the seventeenth century onwards. The historic period overkill of marine animals, despite their huge original numbers and their enormous regenerative capacity, happened very quickly due to the mass killings carried out by European and American sealers who were able to reach the breeding places that were normally inaccessible to the indigenous peoples. These changes were too great and happened too fast. They truncated the balance that had been achieved over a long time span without allowing enough time for the established reproductive system to adjust. We can conclude that technological changes (the adoption of new techniques and materials) were gradual and constant over the long term, but were not necessarily accompanied by structural changes *per se* in the society, whose capacity for continuity was frustrated by a conservative strategy of social reproduction. The Yamana society as such disappeared, like so many others of its type, when it came into contact with another whose strategy of social reproduction was diametrically opposed. The incorporation of different technology implied neither demographic intensification nor development, but quite the opposite.

In conclusion the evolutionary pattern in our first case study involved limiting population growth (despite maintaining a relatively high population density) and adopting some minor technological developments in order to avoid the high cost of a big social and technological jump to a more complex society.

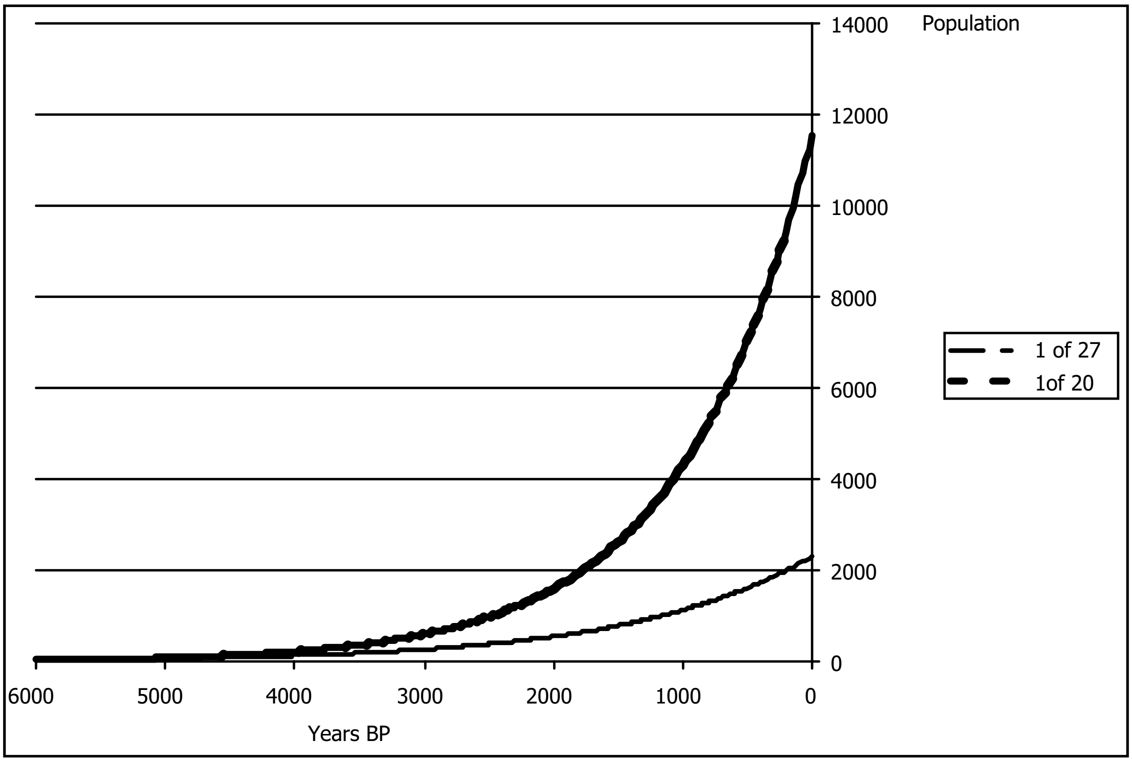

Fig. 2. Population growth simulation curves over 6000 years starting with a group of 30 people. Lower line depicts a rate of only one woman in 27 producing more than 3 fertile descendants, while upper growth line reflects one in 15. Both produce final populations well below human carrying capacity.

The Cantabrian Coast: A Long Sequence of Changing Hunter-Gatherer Societies

The Cantabrian coast is situated in the north of the Iberian Peninsula and lies on an east-west axis at a latitude of 42° north (Fig. 1). Due to its position, it nowadays enjoys a mild oceanic climate with heavy annual precipitation and moderate variations in temperature. Its relief is created by the existence of the Cantabrian Mountains running east to west and rising to heights of over 2500 m in the western half of the range. The proximity of this mountain range to the sea creates a wide variety of ecological niches within 30 km of the coast. This diversity is magnified by the differences among the major valleys that generally run from south to north. The steep gradient of the mountains resulted in a marine transgression after the last ice age that flooded only a relatively small area and, in most cases, the Pleistocene coastline was less than 10 km from where it stands today.

There are extensive archaeological remains throughout the Cantabrian region that date from the Middle Pleistocene and document a relatively late process of Neolithization after 4500 cal BC. Their analysis allows us to identify transformation processes within local hunter-gatherer communities over a long period of time. For this reason the region provides an excellent opportunity to investigate the subsistence strategies of the last foragers, the changes they went through compared with other groups at the end of the Pleistocene, and, finally, how their existence ended in the context of the progressive Neolithization of Atlantic coastal areas of Europe. Other researchers who have studied these issues in the area have sought an explanation for change in causes unrelated to the social and economic organisation of these groups. Ecological factors have played a central role in these explanations, both on a macroclimatic level (Altuna 1990, 1995; Arias 1991, 1992; Clark 1983a; Clark and Straus 1983; Quesada 1998; Straus 1992, 1995) and from a microgeographic perspective centred on local resource patches (Bailey 1973, 1978, 1983; Clark 1983b, 1995; Clark and Straus 1983). It is true that the foragers of the Mesolithic lived in progressively milder climatic conditions with fewer climatic fluctuations than were characteristic of the end of the classical Würm IV glacial substage (Hoyos 1995; Leroi-Gourhan and Renault-Miskovsky 1977). Milder conditions were finally established around 8000 cal BC. As an alternative or complementary factor, demographic growth has also been used to explain the progressive diversification of faunal exploitation at the end of the Pleistocene, changes in settlement patterns, and the technological modifications of the Mesolithic (Aura et al. 1998; Bailey 1983; Clark and Yi 1983; González Morales 1982, 1992; González

Sáinz 1989, 1992; González Sainz and González Morales 1986; Straus 1981).

Changes over Time

Though the economies of the inhabitants of the region did change at the end of the Pleistocene, the archaeological record reveals that the pace of these changes increased after 13,000 cal BC. In the late phases of the Magdalenian Period, specialised hunting systems that had been gradually developing during a large part of the Upper Palaeolithic slowly began to broaden. In the centuries that followed, these changes spread to other spheres of social activity, such as the production of artefacts, the exploitation of plants, settlement organization, as well as symbolic and ritual activities. This suite of variations has justified these groups being referred to as Epi-Palaeolithic or Mesolithic, depending on the author, and they have often been perceived as decadent compared with the "high hunter cultures" of the Upper Palaeolithic. But what were the underlying parameters of these faster changes? Rather than list the individual features gleaned from archaeological data, we will describe the general factors that, in our opinion, generated these evolutionary changes.

Throughout the Upper Palaeolithic in Europe, the production of food was increasingly oriented towards the hunting of medium-sized herbivores (artiodactyls and, to a lesser degree, *Equidae*) and restricted to one or two primary species. In the north of the Iberian Peninsula this process was complete at about the time of the glacial maximum (coinciding with the Solutrean and Late Magdalenian periods). This period was the highpoint of a trend that starts at the beginning of the Upper Palaeolithic and developed throughout the different climatic phases of the last stadial (the Würm IV stage). The main species hunted was the red deer (*Cervus elaphus*) and to a lesser degree the mountain goat (*Capra pyrenaica*). Although there is an east-west gradient in the relative abundance of deer, evidence suggests that variation in the representation of ungulate species in different faunal assemblages is mainly the result of the location of each settlement (Altuna 1990, 1995, González Morales 1982, González Sainz 1989, 1992, among others). Consequently, at sites situated in areas where the terrain is steep there is greater exploitation of goats, whereas at sites located in areas of much less abrupt terrain, the predominant species was red deer. However, in some settlements one observes an interesting alternation between samples dominated by goat or deer that cannot be explained by environmental factors. The cause should perhaps be sought in the different biotopes that were exploited during different episodes of occupation.

Whatever the explanation may be, the pattern reaffirms the existence of specialised hunting systems and the specific function of settlements within them. This could indicate a logistical strategy of territorial occupation (*sensu* Binford 1980). From about 13,000 cal BC onwards, archaeofaunal remains reveal a progressive increase in the presence of other species of mammals, birds, fish and molluscs (which, although they also appear earlier, do so in much smaller numbers). This process has commonly been interpreted as the regional manifestation of the "Broad Spectrum Revolution" that characterised the majority of European Mesolithic societies in Europe (Castaños 1992; Clark and Yi 1983; González Sainz 1992; Straus 1992). Principally in the western Cantabrian region after 8900–9000 cal BC one observes large accumulations of shell at sites both in previously occupied and new settlements. Many caves and rockshelters were filled with shell middens several meters high.

At the same time, the relative uniformity of the technological complexes of the region was broken. In the eastern half one observes a progressive trend towards the microlithization of the preceding Azilian industries, which was based initially on a large number of artefacts on microblades. After 11,500 cal BC, the industry centred on obtaining geometric microliths from local sources of flint, as had occurred in the preceding phase. Initially, this process is also observed in the western half of the region, but ends suddenly around 8900 cal BC. The Mesolithic industry in the west is characterised by small groups of artefacts made in a very expedient fashion on barely retouched cores and flakes. Quartzite, which was found locally, was the main raw material used. In both areas, bone and antler tools decrease appreciably, until they almost disappear in the west.

Based on the remains of medium and large mammals present at sites of this period, most Mesolithic scholars maintain that the foragers of the Cantabrian coast during the Holocene progressively diversified their subsistence in order to take maximum advantage of the wide variety of foods available in the thermophile forests. However, a more detailed explanation is necessary here. Study of the level of polarisation of these remains shows that, broadly speaking, there was indeed a decrease in the dominance of a single species of hunted mammal (Gassiot 2000). However, this relative widening of the spectrum is not linear throughout the region. Fig. 4 shows the average of dominance index (Estévez 1979) for species of ungulates from sites in both segments of the Cantabrian region between 18,500 cal BC and 4500 cal BC. In brief, an analysis of this data reveals that taking into account only ungulate mammals in the quantitative analyses (which is the usual procedure), there is diversification of subsistence, but on a very small scale. In all the periods, the NISP of the dominant species accounts for more than 50% of the total NISP for all species. This pattern produces positive values for the dominance indices.

The trend to decreased polarisation is more marked in the eastern region where the lowest levels of specialisation are apparent at the end of the Pleistocene and during the Holocene. In the western half, the process is not continuous. During the period between 11,500 cal BC and

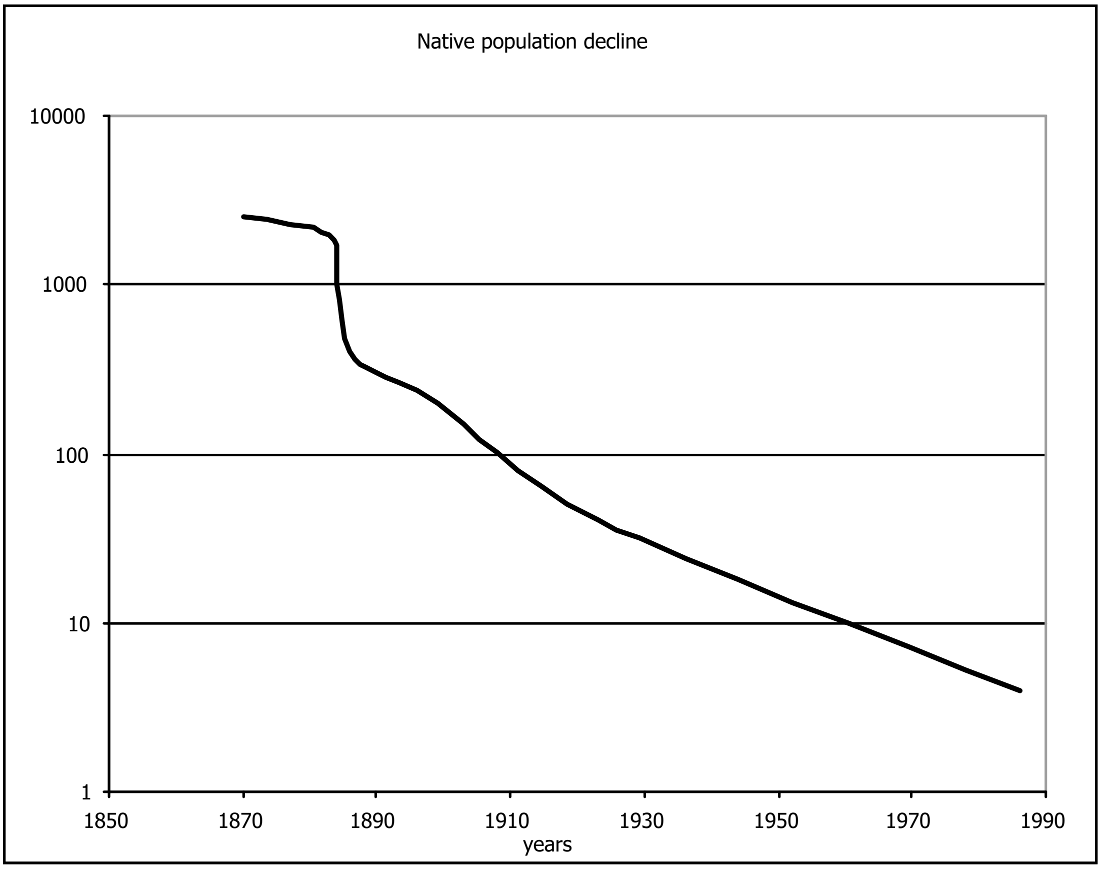

Fig. 3. Native population decline in Tierra del Fuego following the impact of European seal hunters on local marine resources.

8900 cal BC (the classic Azilian Period), when a wide variety of archaeofauna existed, one observes a clear polarisation in the hunting of medium-sized mammals mainly in favour of deer. The decrease of this index during the subsequent Mesolithic period is based, moreover, on a small number of samples from sites with a very low NISP.

The dominance and specialisation indices for sites in the western half of the Cantabrian coast are higher than those for the eastern half in all the periods. A paired t-test comparing the sequence of dominance indices from western and eastern Cantabrian sites shows a significant difference between them (hypothesized difference = 0, DF = 4, p = 0.1330). However, the difference between the two areas clearly increases in later periods. This is an interesting observation that is related to a break in general technological patterns for the whole region and the appearance of shell middens mainly in the west. This is also to be expected in a context of diversified subsistence and greater orientation of production towards the exploitation of local resources. Returning to the diversification in hunting, a number of authors have linked this to processes of economic intensification, in which investment in labour is increased in order to obtain greater outputs by means of the exploitation of less profitable resources. In accordance with this line of reasoning, the pressure that intensive hunting can put on a given species may affect its capacity to reproduce and thereby reduce its density. Regardless of whether this did in fact happen in the Upper Palaeolithic or not, any increase in the degree of specialisation produces a change in the relationship between human activity and the animal species in question, which may manifest itself in the way that the latter is exploited. At first it may result in greater exploitation of sub-adult individuals and, second, in the increased consumption of parts of the anatomy that confer much less benefit. In the long term, both factors affect the general efficiency of hunting a particular species and encourage the search for alternatives. Davidson's studies in the east of the Peninsula (1989) also suggest that continuous pressure through selective hunting may have affected the sexual dimorphism of goats and deer in different ways.

Given the high level of fragmentation that the faunal

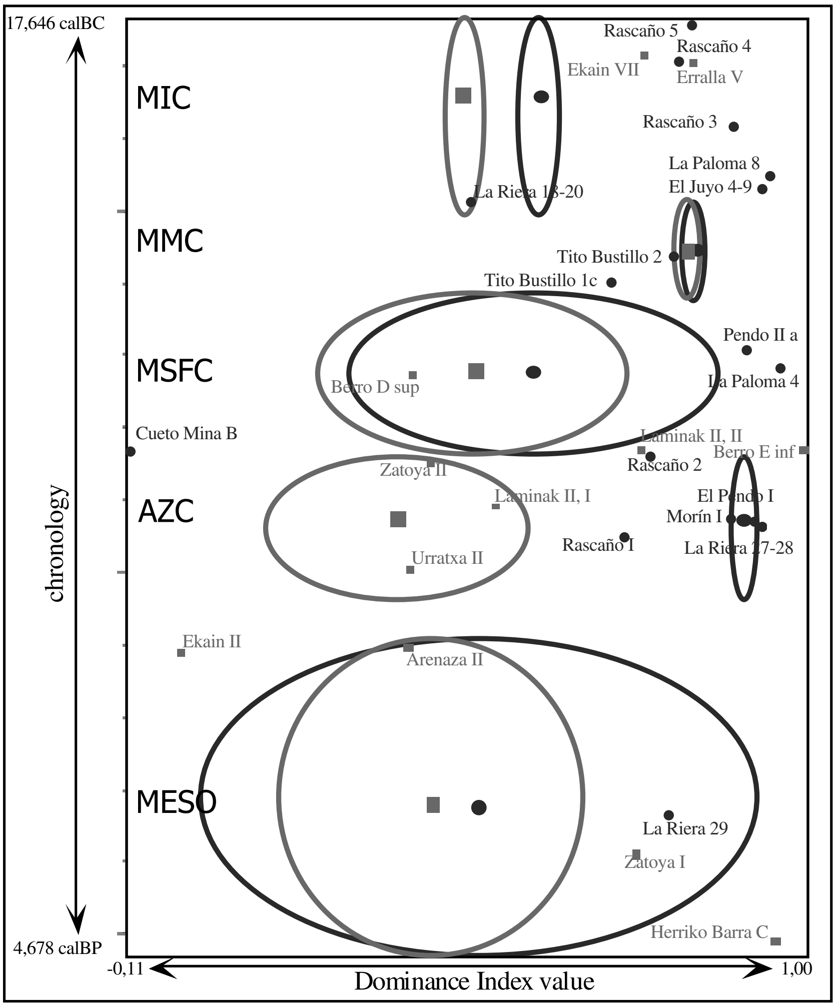

Fig. 4. Trends in dominance indices for the Cantabrian Coast area between the early Magdalenian and Mesolithic: MIC = Early Magdalenian; MMC = Middle Magdalenian; MSFC = Late Magdalenian; AZC = Azilian; MESO = Mesolithic. Western Cantabria = dark grey line and squares; Eastern Cantabria = light grey lines and circles. Ovals indicate 1 standard deviation around the mean for each period and zone. Individual sites with extreme values are also included.

remains of this period display (another potential indicator of an increase in the exploitation of the product of the hunt), calculations of the age of hunted animals are not very reliable. Nevertheless, it is possible to examine the second implication – that of greater exploitation of low utility animal portions. A comparison of the anatomical representation of deer remains between archaeological and taphonomic samples has revealed a number of interesting facts (Gassiot 2000).

1. There is an increase in the transport of the axial skeleton, which has a lower meat value, to archaeological sites. This increased presence of axial skeletons is coherent with a greater exploitation of the carcasses and cannot in this case be explained by taphonomic factors related to different methods of preservation or the greater identifiability of the appendicular bones (as the increased fracturing affects all parts of the skeleton).
2. In general, the exploitation of the carcasses is greater at sites in the western half, where the degree of polarisation is also greater.
3. Diversity within each period is very high. The highest regularities are observed within each site, where the indices of exploitation during each occupation display relatively similar values. It would appear that the location of the settlement in relation to the hunting grounds was the most decisive factor influencing the transport of animal parts to the place of consumption. Having said that, sites with long sequences tend to have a progressively greater presence of parts of the axial skeleton. For the exploitation of mountain goat, an increase in the

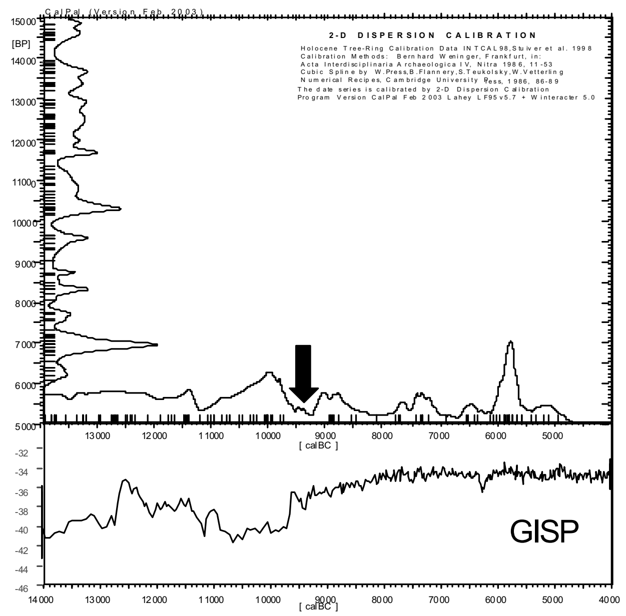

Fig. 5. Cumulative probability curve of the reliable calibrated ^{14}C dates for Cantabrian sites generated with CALPAL 2003. The arrow marks a gap of more than 500 years (just before 9000 cal BC) between sites classified as Azilian on the left and those of the later Asturian and Mesolithic on the right.

ratio of fore limbs to hind limbs seems to prompt a similar explanation (Gassiot 2000), though we will not deal with this issue here.

In parallel with the signs of economic diversification and intensification of exploitation of mammals, there is an increase in the consumption of birds, fish, and molluscs of terrestrial and, later, marine origin. However, these fauna have received little attention from researchers prior to the 1990s and there is little solid quantitative data available to characterize this trend. Unfortunately, recovery methods have without a doubt caused the under-representation of icthyofauna. Nevertheless, the appearance of shell middens may also be related to general changes in subsistence. All the shell middens of the region, without exception, date to after 10,500 cal BC. This fact has often been explained with reference to the postglacial marine transgression, which would have flooded littoral Palaeolithic settlements. However, the fact that multiple shell middens of land snails appear in the western Pyrenean area during the Holocene lends weight to the idea that this phenomenon is related to the economic changes of the period. In short, these data seem to indicate that the intensive exploitation of marine and land molluscs was one more component of a process of diversification of subsistence and increased utilisation of the resources of the local environment by the last foragers of the Cantabrian coast. This process will become much more obvious when quantitative data of all the different types of fauna that were consumed can be included in the analysis. Likewise, improvements in excavation and recovery of archaeological remains are allowing researchers to obtain data that confirm an increase in the consumption of plant foods during the Holocene (González Morales 1995).

Discussion

The hypothesis of continuity between the Upper Palaeolithic and Mesolithic hunter-gatherers on the Cantabrian coast has made possible an evaluation of the economic changes that took place in evolutionary terms. This has fuelled numerous studies of the last foragers of the Atlantic coast of Europe. However, in the coming years researchers need to solve a significant problem that currently raises doubts about models of continuous development. The calibration of 245 absolute dates available from 19,000 cal BC (the Early Magdalenian) through Neolithization (4500 cal BC) reveals a hiatus of around 900 years between the earliest chronological limit of the Mesolithic and the latest phase of the Azilian Period (Gassiot 2000). There is an unexplained gap between 9750 to 9000 cal BC, (between the dates of the most recent Azilian levels and the oldest Mesolithic) suggesting cultural discontinuity. Another possible explanation, and in this case a continuity hypothesis could still hold true, is that there may be a problem in the calibration curve for this period. In the coming years, both an increase in the number of calibrated dates and future research into the translation of radiometric dates into calendar dates for the end of the Pleistocene should shed some light on this problem.

Concluding remarks

The archaeological sequence of the Cantabrian coast illustrates a number of interesting aspects for the study of hunter-gatherer societies. First, both the specialised hunting process and the later "Broad Spectrum Revolution" developed during changing environmental conditions characterised initially by the intense and fast fluctuations of the Late Glacial Maximum and later by the climatic oscillations of the Last Termination. This effectively illustrates that we should not attempt to understand the economy of these groups as dictated linearly by what the environment had to offer. An additional observation makes this point clear. Despite the paleoclimatic differences of the Last Termination between the north of the Iberian Peninsula, southwest France, the eastern Pyrenees, and the Mediterranean area, the processes of social change followed parallel courses with a similar chronology. Second, the process of economic diversification of the Mesolithic communities should be understood in relation to previous specialised hunting systems and as a way to resolve their internal contradictions. The broadening of ecological niches typical of the end of Upper Palaeolithic and the Mesolithic in many European regions, despite being difficult to correlate with more extensive changes in the conditions of the environment, do match local ecological conditions. An example of this is the kind of animals and plant foods that were consumed. However, within them lie causalities that stem from tensions between the need to increase economic territories due to hunting polarisation and the social and labour costs that this implies. Finally, on the Cantabrian coast, the exploitation of littoral fauna is linked with a very late process of Neolithization that occurred in the second half of the 5th millennium cal BC. This phenomenon has also been observed in other areas where Mesolithic communities exploited a wide range of littoral and marine animals, such as on the Jutland Peninsula or the central coast of Portugal. In both cases, as on the Cantabrian coast, when the earliest forms of domestication are finally introduced they do not represent a dramatic break with former lifestyles, nor do they show any evidence of previous technical or social complexity.

The Caribbean Case: Hunter Gatherers on the Edge

Despite a general shortage of archaeological data, the prehistory of the Western Caribbean provides an interesting comparative reference point for the study of the last forager societies living in coastal environments in boreal latitudes. Their environmental conditions, which were generally dominated by a humid tropical climate, offer considerable diversity. These conditions are due as much to latitudinal variation among the different areas of the region as to the microecological diversity of the majority of its coastal areas. The succession of continental tropical rainforest, open savannah, swampland, lagoons, exterior coasts and cays combines with the markedly seasonal nature of the precipitation to create extensive biodiversity. The pollen columns analyzed for the highlands of Central Panama and the area surrounding Bluefields Bay in Nicaragua display a broad stability in climatic conditions from the beginning of the Holocene (Piperno et al. 1990; Urquhart 1997). In the littoral areas the greatest environmental changes are related with the marine transgressions and regressions of the Middle Holocene and with the processes of silting up of coastal lagoons and the formation of new sandbars.

Very little is known about the pre-Neolithic settlement of the area during the Paleoindian and Archaic periods (Keegan 1994; MacNeish and Nelken-Terner 1983; Veloz 1991). Nevertheless, the study of several sites and specific areas provided some interesting results (McGimsey 1956; Ranere and Cooke 1995; Willey and McGimsey 1954) and revealed that the scarcity of data is simply the product of the small quantity of archaeological research that has been carried out. The analysis we present here is the product of our research in Bluefields Bay and Pearl Lagoon in Nicaragua where, since 1998, we have located over 80 shell middens. Research in this area has enabled us to compile a sequence of absolute dates between the present and 1500 cal BC (Gassiot and Palomar 2001). Data from the excavation of shell midden 4 at the Karoline site (350 cal BC–350 cal AD) offers an in-depth view of the agricultural societies of the area that can be contrasted with the parameters that define the forager communities of the Archaic. This view of the lifestyles of the last foragers of the southwestern Caribbean and its comparison with those communities that followed offer clues that help us to understand how the last hunter-gatherer-fisher economies functioned and the general parameters of their evolution.

Caribbean Forager Settlement

Diverse evidence suggests that settlement of the tropical rainforest of Central America took place at the end of the Pleistocene. This contradicts the thesis (Bailey et al. 1989) regarding the inability of hunter-gatherer groups to exploit this kind of environment. Bifacial projectile points with a morphology similar to Clovis, Fishtail, and others, as well as evidence of their manufacture (Acuña 1983; Brown 1980; Coe 1960; Snarskis 1977), have been recovered as surface finds from different parts of the isthmus. In the central mountain range of Panama a small number of levels of occupation have been dated at around 10,500 cal BC (Ranere and Cooke 1995). The number of sites of this age increases notably in the centre of Mexico where there has been much more archaeological research (MacNeish and Nelken-Telner 1983). Evidence from both Panama and Mexico reveals that these groups based their subsistence on the hunting of a variety of land mammals using technologies similar to large mammals hunting groups in the southwest United States. The exploitation of deer (and occasionally of mammoths in Mexico) was supplemented by small mammals and presumably by plant foods. As far as the Atlantic lowlands of Central America are concerned, we only have information from sites excavated in Belize that contained a bifacial point industry (Lowe-ha Phase). Unfortunately, there are no absolute dates available.

There is more evidence for the presence of foragers in the Central American lowlands during the Holocene. The most revealing sites are once again found in Panama, such as the primarily shell midden sites of the central Pacific Coast around Parita Bay. The best-known of them, Cerro Mangote (McGimsey 1956), has been dated to around 5700 cal BC and consists of a mound of shells over 50 m long containing many burials in structured groups. This gives credence to the possibility that the middens were the product of fairly stable groups that inhabited the area for relatively long periods of time. At this time subsistence was based on the varied exploitation of marine molluscs, especially oysters and crabs, estuarine ictyofauna, land mammals such as white-tailed deer, peccary and racoon, as well as turtles and birds. The presence of milling stones and grinders among the stone artefacts also indicates the processing of wild plants. The stone industry was very expedient and manufactured on local raw materials. The first use of pottery in the area takes place in a very similar context with the complete absence of evidence for the exploitation of domestic plants, and where subsistence and technology display characteristics of the preceding period at sites such as Monagrillo (Willey and McGimsey 1954), dated between 3000 and 300 cal BC (Ranere and Hansell 1978). The combination of an expedient industry and a diverse exploitation of the environment are features that are also present at the Archaic sites of the central highlands of Panama.

In the lowlands of the Caribbean, the sequence developed for Belize illustrates a similar process (MacNeish and Nelken-Telner 1983). During the Holocene the lithic industry progressively incorporates a considerable variety of morphotechnical types at the same time as, in general terms, flaking processes are being simplified. The presence of milling stones and stone bowls after 5900–5000 cal BC suggests the processing of plant foods, which increases throughout the rest of the sequence. Moreover, from this period onwards there is evidence of the exploitation of littoral and marine fauna, the importance of which increases in later phases. In Nicaragua, the 6 m shell midden excavated at Monkey Point dated to between 6100 and 3700 BP (information supplied by J. Espinosa 1998) also reveals recurrent settlement in this place by forager groups. Among the varied fauna that has been recovered are the remains of deepwater species such as shark, as well as land mammals. Numerous milling stones form part of the stone industry at this site. Turning to the Caribbean islands, a number of large shell middens like that at Banwari Tracé on the island of Trinidad (Veloz 1991) also suggests the presence of fairly stable settlements with a similar chronology to that of the mainland coast. Even if these communities were not of a sedentary nature, they regularly inhabited the same places and generated large quantities of waste.

Southwestern Caribbean Farmer Settlement

The exploitation of marine and littoral environments continued throughout virtually all of subsequent prehistory. On the Atlantic coast of Nicaragua there is a sequence of shell middens that runs from 1500 cal BC to 1000 cal AD. This sequence is notable for its geographical and temporal variability both in terms of the fauna that was consumed, the characteristics of the shell middens, and the position they occupy within the economic practices of these groups (Gassiot 2002b). Shell midden Number 4 from the Karoline site stands out in this respect. It has been excavated recently (Clemente and Gassiot 2002) and has revealed an area of domestic activity with abundant remains of ictyofauna, land mammals, birds and fruits as well as marine and estuarine molluscs. A variety of wild fruits and seeds were also part of the diet. It is likely that the fragments of calcified wood are the remains of a variety of yucca, which would confirm the existence of some form of agriculture. The nearby Rocky Point midden has revealed the hunting of manatee (*Trichechus manatus manatus*), an aquatic mammal exploited in many parts of the Caribbean over a long period of time, including the Archaic period (McKillop 1985).

Data available for the region shows a wide and diverse exploitation of a variety of animals and biotopes during the last three millennia of prehistory, mainly by groups that practised some form of agriculture. Such is the case of the lowlands of Belize where at Preclassic and later sites it is common to find extremely diverse faunal groups with a notable presence of aquatic taxa (mainly molluscs and fish) (Vail 1988).

Discussion

Forager settlement of the Central American side of the Caribbean is poorly documented in comparison with the other two cases discussed in this paper. However, as in Tierra del Fuego and the Cantabrian Coast, it is possible to see processes of change in the hunter-gatherer societies despite a backdrop of general environmental stability. Transformations took place in terms of their technological industry, with the simplification of many manufacturing processes, and in terms of the reorientation of their subsistence towards the intensive but wide-ranging exploitation of the local biomass. This diversification in the acquisition of food contrasts with a previously more restricted hunting spectrum that was centred on mammals in the last part of the Pleistocene. The sites in Belize and Panama illustrate how this transformation was slow but constant. For the last forager communities this economic organisation combined with increased stability of settlement that either adopted a year-round pattern or recurred regularly at the same places based on seasonal cycles. The development of agriculture did not represent a major departure from preceding lifestyles, as was the case in the Archaic communities of Central Mexico. Moreover, the varied exploitation of the environment continued to take place even in very different social contexts, such as the coast of Belize during the Classical Mayan Period.

Final Discussion

The case studies presented here provide examples of last forager societies living in littoral environments in three parts of the planet with very different climates. All three developed an intensive exploitation of a wide variety of local resources that was compatible with a notable level of opportunism and simultaneously with a number of highly specialised and sophisticated production methods (such as the bow and arrow, canoes and harpoons). In at least two of these cases this way of life was the result of the progressive transformation of preceding forms based on a higher level of hunting polarisation. Likewise, all three developed stone technology that was largely based on the reduction of the labour investment in tool production through the use of local rocks and the simplification of the processes of manufacture. The exception of the Fuegian bifacial points with flat retouch is perhaps simply incidental, as is suggested by their rapid substitution when Europeans introduced an alternative material that was easier to work. Moreover, this form of lithic manufacture was rapidly abandoned; ethnographic reports state that it had ceased to be practiced by the end of the nineteenth century.

These examples contrast sharply with those archaeological contexts where hunter-gatherers were oriented towards the specialised exploitation of ungulates, such as in the preceding Magdalenian and Paleoindian periods or with contemporary groups such as pedestrian hunters of continental Patagonia and the north of Tierra del Fuego in relation to the Fuegian canoeists. In all three cases we detect certain shared parameters that underlie a number of divergent practices, which are the product of the specific geographical and historical contexts of each case. Most significantly, the three examples of foraging communities studied show signs of internal evolution that do not correlate with changes in their environmental conditions. The respective archaeological sequences illustrate variations in the objects exploited for subsistence in the Caribbean and Cantabria as well as technological changes in all three cases. This fact makes it difficult to suggest that the subsistence and social organisation of these groups were an adaptation to specific geographical environments. The relationship between consumption patterns within the framework of different production cycles and the configuration of available resources was, in none of the cases, a situation that was closed and fixed in time. The wide geographical spread of a number of the phenomena studied, as well as the economic and social transformations during the Mesolithic in the Cantabrian-Pyrenean area, prevent attributing these changes to the fact that these societies inhabited littoral environments.

Throughout this paper we have outlined the factors that influenced the specific changes of the last forager societies we have analysed, though more completely in Tierra del Fuego and the Cantabrian Coast where there more data are available. Some lapses in the settlement sequence (marked by a lack of ^{14}C dates) or ruptures in the development sequence of tool sets suggest periods of crisis both in Cantabria and Tierra del Fuego that do not correlate with changes in the environment. In both cases, the explanation is to be found in the social conditions of these groups and the labour organisation designed to provide each group with the means necessary for their subsistence (and for those linked with their biological and social reproduction). Again, as in Darwin's time, the isolated position of Tierra del Fuego and its island character makes this case a very useful laboratory example.

The idea that the problem is closely linked with social production or, to put it another way, that it is related to the strategies of resource and labour force management, creates a number of interesting challenges for our discipline. Although it is true that the orientation towards the exploitation of littoral resources in the three case studies did indeed impose a series of common organisational and technical facilities regardless of the diversity of environments involved, this did not influence the timing of changes or the ultimate fates of the social formations considered. It is clear that factors of place and time in relation to the resources that a given environment makes available are an aspect that must be included in our studies. To deny their importance would be tantamount to denying the very material foundations on which all social life is based. It is necessary to identify the work processes, the time needed to carry out different activities, the structure and dynamics of the output of each activity, the usefulness of the products and their relationship with possible needs, an other similar elements in order to establish wider explanatory models. Having said that, it is also necessary to explain under what social conditions any range of resources were exploited from the perspective of the range of objects that were present within the social structure of the communities.

To approach this problem it is necessary to go beyond the simplistic categories that have hitherto been established and which are often applied schematically and mechanically. The littoral-inland, foragers-collectors, or specialised-broad spectrum dualities ignore a much greater subtlety that requires very accurate analysis of variability not only in terms of space but also in terms of the comparison of development over long time scales in relation to shorter ones. To make this effort means, in short, to view history within our discipline not as a vague succession of cultures, but as the way human groups defined their lives over time. There is still much work to be done even in an area like Cantabria, where scientific archaeological studies have been carried out for over 100 years.

Acknowledgments

Our research projects in Tierra del Fuego and Nicaragua were supported by the European Union, the Spanish Ministry of Education and Culture, the Ministry of Science and Research and the Spanish Agency of International Cooperation of the Spanish Foreign Affairs Ministry. The English translation was done by Mike Gates of the Translation Faculty of the Universitat Autònoma de Barcelona.

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Ermengol Gassiot Ballbè and *Jordi Estévez Escalera*
Departament de Prehistòria
Universitat Autònoma de Barcelona
Edifici B,
08193 Bellaterra,
Spain
E-mail: ermengol.gassiot@uab.es
jordi.estevez@uab.es

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 106–125

9. Complexity among Hunter-Gatherers from the Pampean Region, South America

Daniel Loponte, Alejandro Acosta and Javier Musali

This paper summarizes studies of complexity among hunter-gatherers as a backdrop to examining the regional archaeological record of complexity in the Lower Paraná wetlands of South America. These wetlands were rich yet uneven in their productivity, but providing two main resources that could support high human population densities – fish and vegetables. At 1000 years BP, these resources were the main sources of food that supported populations of complex hunter-gatherer societies in the wetlands. Human circumscription, a focus on one or two main resources with a marked seasonality, localized catchments, the prevalence of vegetable foods in the diet, resources captured in mass using highly specialized technology, and precise coordination of labour for resource production were all evident at the time in the region, and represent a suite of conditions and practices that promoted complexity among wetlands groups. Interestingly, hierarchical social organization was not prominent among these groups. In addition, regional similarities in pottery styles, funeral patterns, technological designs and other stylistic-symbolic material culture indicate the existence of widespread populations interlinked in social, technological and symbolic spheres. Hinterland bands provided access to a long distance exchange system to the West, and were part of the annual aggregation of wetlands populations. This widespread interaction network needed planning and anticipation for all the components of the system to function. In these respects, the wetlands provide an important case study that demonstrates critical linkages in complex hunter-gatherer systems.

> *It seems that nature has chosen to be economical.*
> *R. Parwani*

Introduction

Human societies are not simple structures, and thus the category of "complex society" can be used only in a comparative sense. Seminal definitions of hunter-gatherer societies from the 1960s and 1970s (e.g., Lee and Devore 1968; Sahlins 1968, 1972) depicted them as the simplest of human organisations. It is now recognized that the image of the Kalahari foragers presented in some accounts led anthropologists to a distorted and simplistic understanding of hunter-gatherers (Binford 1980; Woodburn 1980). It is evident that one of the intrinsic features of human culture is its capacity to bear increases in the number and kinds of interactions among its different components. With the exception of periods of exploration and initial colonisation of new regions, human societies exchange goods and information with other societies. These observations indicate that human societies are anything but simple structures, being intermingled in large-scale, complex systems.

Yet, for thousands of years humanity did exist as relatively simple foragers, likely because there were few pressures promoting more complex organizations. The development of complex organization among hunter-gatherers therefore has a deep evolutionary significance (Smith 2001), and on this basis the concept of complexity should be very useful to synthetically describe a coherent approach to human organization. Yet, because the definition of complexity is manifold (Standish 2001), its use in archaeology has been a little vague. Various authors use "social complexity", "economic complexity", and even "social inequality" as synonymous, fostering some confusion. Social inequality is particularly problematic as a core feature of complexity as inequalities can be found even in the simplest foragers (Cashdan 1980; Flanagan 1989). Admittedly, these inequalities are very different from those in societies with institutionalized ranking. When social inequality becomes truly institutionalised, it is typically because a society is already very complex, or, more often, their economy is agricultural (Price 1995; Smith 2001). Because of the variable forms inequality can take, we shall avoid using "social inequality" as synonymous with complexity.

In order to clarify and make more concrete some issues surrounding complexity, in this paper we consider the archaeology of the Lower Paraná wetland of South America. This area has an interesting record to explore from the point of view of hunter-gatherer complexity. We first present a brief summary of existing perspectives on complexity in archaeology in order to develop an understanding of complex society applicable to the Paraná region. We then turn to the regional archaeological record of the Paraná wetland.

Discussing Complexity

During the 1980s and 1990s, a corpus of archaeological discussions of complex hunter-gatherer societies were published. Theoretical discussions focused mainly on recognizing the properties and causes of the development of complexity in human societies. Some of the properties taken into account (though differently emphasized) include:

1. The size of a society and its demographic density (Brown 1985; Kosse 1994; Price 1995; Price and Brown 1985).
2. The variety of social roles and the integration of its parts and their specializations (Fitzhugh 2003; McGuire 1983; Price 1995; Price and Brown 1985; Tainter 1996).
3. The variety and intensity of organisational mechanisms, including alliances, territoriality, and complex production modes (Bender 1978; Kelly 1995; Price 1995; Price and Brown 1985; Rowley-Conwy 2001).
4. The existence of asymmetric social relationships, where costs and benefits are not balanced among individuals (Arnold 1996; Hayden 1996, 2001; Keeley 1988; Price and Brown 1985).
5. Delayed consumption (Keeley 1991; Kelly 1995; Rowley-Conwy 2001; Woodburn 1980).
6. Particular forms of land use, including low mobility and sedentism (Keeley 1991; Kelly 1995; Rowley-Conwy 2001; Woodburn 1980).
7. Construction of non-transportable and specialized equipment (Nelson 1996; Price and Brown 1985).
8. Existence of hereditary hierarchies (Arnold 1996; Hayden 2001).
9. Modification and signalling of landscapes (Rowley-Conwy 2001).

Many archaeologists (including those cited) recognize that (1) more than one of these elements are important, (2) many of these elements are linked, and (3) various properties of complexity have different levels of visibility in the archaeological record. The diverse theoretical orientations of researchers have resulted in some of these properties receiving little or no consideration, while others have probably been overemphasized and/or have only a local importance. For instance, the production of parietal art cannot be easily linked with complex behaviours in all parts of the world, as some authors have supposed. Other studies have drawn links between the bioanthropological record and social status, focusing on differences in nutritional health and the amount of energy invested in the structure of tombs, body preparation, and grave offerings (Binford 1971; Tainter 1978; Trinkaus 1995; Saxe 1970). However, these features are related more closely to social inequality than complexity, which we have pointed out are not one and the same.

Some scholars consider complexity to relate solely to hierarchical social organisation. This position, which privileges internal factors as the cause of complexity (see Smith 2001), has many supporters with different interpretive objectives (Ames 1985; Arnold 1996; Cohen 1985; Hayden 2001; Hayden et al. 1985; Johnson 1982). Arnold argues that complexity implies the existence of "institutionalised control of some individuals over non-kin labour with hereditary inequality and leadership" (Arnold 1996, 93), setting aside complexity from material aspects related to subsistence, mobility, or storage. Binford (1980) has demonstrated that mobility and storage have no direct relationship, but this observation does not suggest that no link exists between sedentism, property, and complexity. Individual property ownership and social complexity have an intimate relationship, and property and mobility are in many ways a contradiction (Sahlins 1972).

A key relationship in many cases appears to be that complexity is strongly associated with sedentism or annual permanence. Cross-cultural studies have demonstrated that storage has a particular importance for those groups that stay in a single location for longer than five months (Keeley 1991). It should be clear that this is not an explanation for the rise of the complexity, but rather recognition of some important and perhaps necessary pre-existing conditions, such as low residential mobility, for complexity to arise. In this vein, Woodburn (1980) introduced the concept of delayed return as a vital component to understand complex systems. Although some authors have argued that all hunter-gatherer systems have storage behaviours (Arnold 1996; also see Binford 1980), what may be more critical is the degree of dependence on delayed returns (Keeley 1991) and the implications of this for human social and technological organization.

Many scholars have eschewed identifying complexity through enumerating the presence or absence of certain features in the archaeological record, finding complexity instead in less material realms such as social structures, particularly in the existence of social hierarchies. But we find that such an approach presents some problems of fit with the archaeological record. First, the archaeological visibility of such hierarchical organisations is usually strongly dependant upon finding hierarchies in the burial practices of the hunter-gatherers. Moreover, this approach is also related to the theoretical assumption (quite uncomfortable for some archaeologists) that a higher number of objects (preferably non-subsistence ones) in certain graves constitutes evidence of the existence of social hierarchies (e.g., Hayden 2001, 238). The amazing variability in death related behaviours (cf. Barrientos 2001) irrespective of the existence of social hierarchies makes that relationship too simplistic. Second, the archaeological and ethnographic record from some parts of South America, as with our lower Paraná wetland case study, points to the existence of complex societies without any evidence of social hierarchies (see also Price 1995 or Smith 2001 for other regions). Third, there were well-established farming societies without hierarchical structures (Kuijt and Goring-Morris 2002).

A more useful view in our opinion is provided by Rowley-Conwy (2001, 42), who considers complexity as a structure that may be defined by three basic properties: sedentism, defence of the territory, and storage. He also adds logistic organization as a characteristic of complex society. His position is particularly productive in that these features (1) incorporate a set of ample organisational interactions relevant to discussing complexity in human societies, and (2) can be investigated in an average archaeological record. Another positive aspect of this definition is that complexity moves from a rigid concept to a continuum, with different degrees of intensity of its features. But this definition carries some negative aspects also. First, cross-cultural ethnographic studies have demonstrated that hunter-gatherer organisation involves logistical structures in high-latitude environments related to environmental factors alone (Binford 1980). Thus, categorising these logistic organisations as complex waters down the definition of complexity to just an organizational necessity. Second, although the existence of storage can be detected in many archaeological situations, it is quite difficult to accurately estimate the dependence of a population on delayed consumption. Third, it is not easy to detect the active defence of the prehistoric landscape.

Alternatively, McGuire (1983) distinguishes inequality and heterogeneity as two fundamental components of complexity. He suggests that it is important to consider not only how many parts exist in a complex system (also see Tainter 1996), but the degree of specialization of those parts as well. Archaeologically, specialization can be viewed as the extent of technological improvement in resource acquisition. Such technological features and implements are easy to incorporate as data into archaeological studies, and doing so allows the archaeological discussion of complexity to be empirically based. Overall, despite some potential methodological and analytical problems, factors such as low mobility and sedentism, active defence of territory, storage dependence, intensification/specialization of the exploitation of the main resources, and the degree of technological development (including specialization) represent, in our view, the critical properties to investigate in the archaeological record of complex hunter-gatherer societies.

Complexity Itself

If an operational definition of complexity is of a very limited scope, for example, the number of constitutive parts and their specialization, it is relatively easy to compare two very different societies, for instance, non-pottery Paleoindian societies of the Pampas and late Holocene hunter-gatherers of the Paraná wetlands, to get some indication of which may be more complex. But it would be more difficult if we want to compare two hunter-gatherer societies very close in infrastructure and technological development. This point can be illustrated with the example of the sand pile model (Fig. 1). Models 1, 2 and 3 have the same number of components and technological degree, but increase in complexity from 1 through 3 considering the interrelation of the constitutive parts. With this simple model, we want to illustrate that irreducibility is another feature of complexity (Nelson 1976). This means that each component is working in an interrelated system, and cannot be understood as an isolated unit; that is, the properties of a system are not exhibited by its isolated elements (Mateos et al. 2002). This implies that to effectively model complexity we need to consider analytical units that measure the interrelations among system components, and thus must look beyond artefacts, technology, or even social structures. These "units of interrelation" have yet to be defined or described in terms of how they may be expressed in the archaeological record. But nonetheless, it is important to consider irreducibility as a property of complex systems.

Complexity, Evolution and Regional Variability

Some scholars believe that complexity refers to something more than its properties. Complexity provides an evolutionary advantage, especially in a competitive

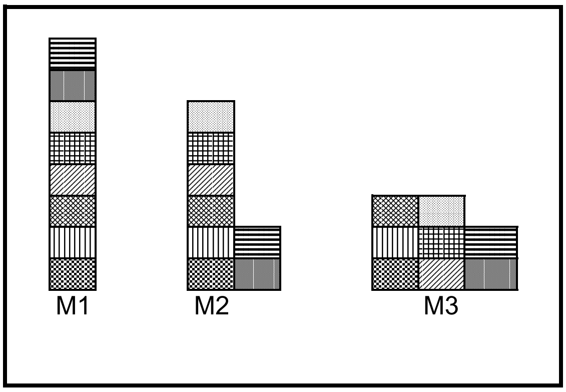

Fig. 1. Schematic representation of the Sand Pile Model. All models have the same number of components, but with respect to the interrelationship of its component parts the second (M2) is more complex than the first (M1) and the third (M3) exhibits the highest level of complexity.

environment (Kosse 1994, 36). As such, it is a selected-for organizational design, probably related to the need to keep social systems stable or improve their stability. However, human history shows a higher rate of change in complex systems. The rate of modification/appearance of new system components is higher in more complex systems and thus can be used in an indirect way to measure the evolution of these systems. Such rapid changes may occur because selection operates simultaneously on a higher number of features. This situation increases regional variability and acts as a stimulus to develop new items of technology and novel forms of social organization. These developments should exhibit a higher degree of concordance with other aspects of a cultural system, substituting for less efficient and less integrated components, generating a faster evolution of the system in an auto-integrative way (cf. Goles and Latapy 1997).

In a similar sense, Heylighen (1996) has suggested complexity increases when high levels of variety and interdependence develop among constitutive parts. This may produce an increase in the spatial scale of interconnected elements, and perhaps also in their temporal scale. These increases in scale can extend to other societies, and so the path to complexity is not taken in isolation. Consequences of increasing scale could be the rise of new styles (variability) and interaction of styles (syncretism). This expansion of styles would be particularly visible in pottery, both in the circulation of finished and raw materials within the entire system. Another outcome may be the production of generalized artefacts that maintain pathways of material and social exchange. Such processes homogenize the regional record. This implies more inter-related behaviours over greater spans of time, including the anticipation of future interactions and more foreplanning in social and subsistence activities. All these processes (appearance rate, syncretism and homogenisation) increase the interdependence and variability of the regional record.

The Rise of Complexity

Various factors have been cited as important in the rise of complexity. Some authors have suggested that the starting point of complexity is the intensification of alliance relationships or social obligations (e.g., Bender 1978) or production for the generation of surpluses for ceremonial activities (Lourandos 1985). Other authors argue that the rise of complexity resulted from: competition amongst aspiring elites (Hayden 1994, 2001); information management requirements (Ames 1985); control over non-kin labour (Arnold 1996, Hayden 1995); or political competition (Fitzhugh 2003). These arguments emphasize social factors, a perspective that is not without criticism (Rowley-Conwy 2001, 47–8).

Another broad perspective, also supported by many scholars, considers demographic pressure and environmental stress to be the ultimate causes that generate complex behaviours (Cohen 1981; Keeley 1991; Kelly 1995). The relationship between complexity and high population density was pointed out many years ago by anthropologists (Carneiro 1967; Ember 1963; Naroll 1956). The basic premise of this kind of argument is that population pressure creates problems that can be solved with complex behaviours (cf. Tainter 1996). It is reasonable to assume that risk minimization promotes higher technical complexity and fosters social alliances. The concentration of resource availability into a short period of time (as is typical of many regions with complex hunter-gatherers) leads to technological complexity, storage and specialisation (Kelly 1995; Nelson 1996; Torrence 1989) – three key properties of the complex systems.

Reliance on plant foods within hunter-gatherers societies may also be important in the development of complex hunter-gatherers. Hames (1990, 96–7) has suggested that plant foods may be redistributed less widely and evenly, as they are more predictable and can be stored at a lower cost. The absence of pressures for redistribution promotes development of a broader concept of individual property and control of resources. Both situations (concentration of resources and medium to high importance of plant foods) may also generate collective or individual defence mechanisms for fixed resource patches. Although complexity often implies a specialisation in one or two resources, it is observed that in many cases the record indicates diversification in subsistence, probably with the aim of either increasing the number of possible responses to the risk inherent in depending on a narrow suite of resources or to increase net margins (cf. Kaplan and Hill 1992). This diversification is only possible in highly productive environments, a connection recognized by many authors (e.g., Arnold 1996).

Likewise, it has been suggested that those human groups that rely on fishing or those with a strong emphasis on marine resources exhibit more indicators of complexity (Arnold 1996; Bean and Lawton 1976; Kelly 1995). Clearly, a dual and integrated economy (terrestrial/aquatic) is by definition more complex than a solely terrestrial one. Furthermore, the structure of some water resources, especially in fluvial or estuary environments, makes their exploitation similar in many ways to agricultural production. Resources appear in relatively small and localised effective catchment spaces for a limited time and can be collected in large quantities requiring storage. Generally, these resources also have very specific properties that can be engaged through the development of sophisticated and specialized technologies aimed at minimising risk and maximising return rates (cf. Torrence 1989).

Finally, the assumption that the rise of complexity initiates a lineal progression from the simplest foragers to complex hunter-gatherers and then to farming has been discounted by numerous researchers (Arnold 1996; Rowley-Conwy 2001; Tainter 1996). However, it is true that food producing societies developed from complex hunter-gatherer organizations.

In the remainder of this paper, we consider the properties we see as typically linked with complex hunter-gatherers societies (low mobility, active defence, delayed consumption, intensification, and technological specialization) in terms of the record of the Pampa region. We explore, first, evidence for the existence of hierarchical structures, and, second, investigate how syncretism and homogenisation are expressed in the record. We consider a fairly short period of time in this study, and so no causal argument for complexity is presented here.

Case Study: The Pampa Region of Environment

The Pampa region is a great plain in the central eastern portion of Argentina between 31° and 39° South. It is bounded by the Atlantic Ocean to the east and the *Sierras Centrales* hills to the west, and includes part of Uruguay and the southern territory of Río Grande do Sul State in Brazil (Cabrera and Willink 1973). Within this great plain, we are specifically interested in the wetlands of the Lower Paraná River (Fig. 2). These wetlands mainly consist of small islands in the Paraná and Río de la Plata rivers as well as a *Transitional Aquatic-Terrestrial Zone* (TATZ) that includes flat prairie plains with little run-off (marshes and swamps). Here, the soils are both scant and shallow, having developed on fluvial sediments left by the Paraná River (Bonfils 1962). The highest elevations of the TATZ are subcircular or elongated natural levees that are regularly left by the periodic flooding of the area. These levees are found along streams, as well as in lagoon and marsh margins, and typically have been colonised by grasses and many species of shrubs and trees. They are also the primary locations where archaeological sites are found.

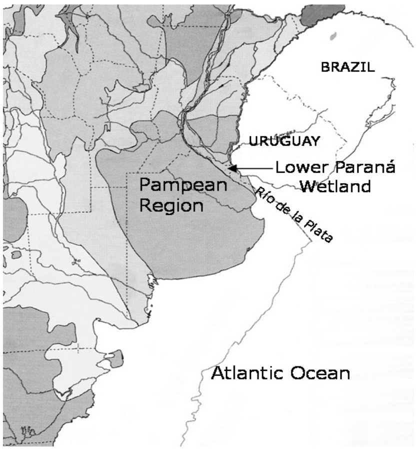

Fig. 2. The Pampa Region of southeastern South America.

The Lower Paraná wetlands are characterized by great variation in environmental diversity and thus local productivity, which is regulated primarily by the water balance of the Paraná. Historically, this river has an ascending hydrometric cycle in winter and a descending one in summer. Every ten years or so there are exceptional pulses related to the "El Niño" phenomenon, which causes catastrophic flooding events (Bó and Malvárez 1999). Annual hydrodynamic observations have demonstrated that these wetlands have one of the strongest hydrologic variations in South America (Bó and Malvárez 1999; Neiff 1999). Periods of flooding and drying of this area are progressive, but, owing to climatic, geomorphologic, and hydrologic conditions, may vary widely in their degree and predictability. Since wetland productivity is related so closely to flood cycles, analysis of flood features (frequency, tension, intensity, regularity, amplitude and seasonality) is crucial to understanding the strategies of human groups inhabiting the area. For example, during winter floods the region has lower resource availability, as terrestrial fauna disperses and fish resources are reduced in concentration.

According to current geomorphologic and edaphologic data, the present landscape dates from a minimum of 1000 BP (Iriondo 1990; Iriondo and García 1993). However, faunal material recovered from archaeological sites including Túmulo de Campana (see Fig. 3) in the riverside flood-plain indicates a minimum date of 1700 BP for a biocenosis somewhat similar to the present (Loponte and Acosta 2002a, 2002c). The geomorphologic dynamics of the Paraná generates new islands at its outlet, advancing on the adjoining Río de la Plata, which recedes at a rate of some ten meters per year (Iriondo and García 1993).

Site	Latitude	Longitude	Economy	Environmental strata	Chronology	Source	Sample
Las Vizcacheras	34° 16' 81"	58° 48' 65"	hunter-gatherer (H-G)	Wetland (continent)	1090 +/-40	Beta 148237	*L. guanicoe*
					1070 +/- 60	LP- 1401	*S. romanzoffiana*
Garín	34°22' 38"	58°42' 30"	H-G (horticulturalist?)	Wetland (continent)	1060 +/- 60	LP-240	*B. dichotomus*
Anahí	34° 16' 95"	58°48' 47"	hunter-gatherer	Wetland (continent)	1020 +/-70	Beta 147108	*M. coypus*
Ao. Guazunambí	34°23' 33"	58° 09' 34"	hunter-gatherer	Wetland (continent)	940 +/-60	Beta 147109	Mammalia
La Bellaca sitio 1	34° 23' 07"	58° 40' 14"	hunter-gatherer	Wetland (continent)	1110 +/- 70	LP-1288	*M. coypus*
La Bellaca sitio 2	34° 22' 79"	58° 39' 53"	hunter-gatherer	Wetland (continent)	680 +/-80	LP-1263	Mammalia
Túmulo de Campana	34° 11' 54"	58° 55' 14"	hunter-gatherer	Wetland (continent)	1640 +/- 70	Beta 172059	Mammalia
Arroyo Fredes	34° 11' 67"	58° 33' 61"	Amazonian horticulturalist	Wetland (Island)	in process	C.A.I.S.	human
Arroyo Malo	34° 21'	58° 39'	Amazonian horticulturalist	Wetland (Island)	in process	C.A.I.S.	human
El Arbolito	34º 10' 11"	58º 15' 00"	Amazonian horticulturalist	Wetland (Island)	405 +/- 40	GrN 5146	
La Bellaca sitio 3	34° 22' 80"	58° 39' 48"	hunter-gatherer	Wetland (continent)	s/d		
Otamendi sitio 1	34° 14' 56"	58° 51' 46"	hunter-gatherer	Wetland (continent)	s/d		
Otamendi sitio 2	34° 14' 54"	58° 51' 45"	hunter-gatherer	Wetland (continent)	s/d		
Otamendi sitio 3	34° 15' 09"	58° 51' 42"	hunter-gatherer	Wetland (continent)	s/d		
Otamendi sitio 4	34° 15' 13"	58° 51' 43"	hunter-gatherer	Wetland (continent)	s/d		
Ao. Sarandí	34° 23' 84"	58° 39' 053"	hunter-gatherer	Wetland (continent)	s/d		
Arroyo Las Piedras	34° 04' 54"	58° 50' 737"	hunter-gatherer	Wetland (Island)	s/d		

Fig. 3. Details of archaeological sites discussed in the text. Chronology dates are expressed in radiocarbon years before present.

Resource Base

The wetlands of the Paraná delta have a great number of gregarious faunal species typically associated with bodies of permanent water or humid environments (Fig. 4). From an economic perspective, the most important species for hunter-gatherer groups were fish (mainly siluriforms of the family Doradidae and Pimelodidae, and Characiformes), coypu (*Myocastor coypus*), cavy (*Cavia aperea*), molluscs (*Diplodon* sp.), Pampa deer (*Ozotoceros bezoarticus*) and marsh deer *(Blastocerus dichotomus*). Siluriform fishes are found in the deeper parts of the Paraná channel, as well as in the border lagoons and streams. Since they inhabit both deep and shallow waters, they may be caught by different methods, including harpoons, traps or nets. The maximum weight for the most common siluriformes species, *Pterodoras granulosus* (granulated catfish), is 9 kg (Arámburu 1985). Most fish are present in large numbers only during the warm season, between October and March. Estimates of the mean density in other areas of the Paraná indicate a peak concentration of 2000 kg/ha during summer (Bonetto et al. 1969). Comparative analyses between winter and summer densities in the Paraná alluvial lakes confirm average values of 4.2 fish/10,000 cubic metres in winter and 86.3 fish/10,000 cubic metres during summer. The main factor causing this increase in summer is ebbing water levels. Overall, 60% of fish density may be explained as resulting from a combination of lower water levels and a seasonal rise in water temperature (Tablado et al. 1988).

The terrestrial coypu is a gregarious burrowing rodent weighing approximately 7 kg. It is closely associated with water environments. Nowadays, they are generally hunted with traps by the local population living along the Paraná delta, though sometimes they are also intercept hunted. The cavy, weighing around 0.6 kg, is a small and gregarious burrowing rodent that is more or less evenly distributed within the wetlands. They are easily caught after a short chase. Another ever-present resource in the deposits of this area is the *Diplodon* sp. fluvial clam, which prefers low energy watercourses. All these resources are abundant when measured in terms of individuals per surface unit. Some may be obtained in great numbers as they are sessile or semi-sessile and therefore very predictable. There is little risk involved in procurement, and they may be captured or gathered by various sex or age groups. All the species listed above have a high reproduction rate, mature rapidly, and propagate quickly, which allows them to be intensively exploited ("r-strategists" *sensu* Pianka 1970). They are available year-round, unlike fishes, which possess longitudinal migratory habits that have not yet been fully studied (Tablado et al. 1988, COMIP 1994).

The marsh deer (*Blastocerus dichotomus*) is one of a number of ungulates that typically inhabit the wetlands. The males weigh up to 150 kg and are mainly solitary, while females gather in groups of 2–3 individuals. Marsh deer move along paths within the wetlands and prefer to come out at dusk (Redford and Eisemberg 1989). Another important ungulate in the wetland is the smaller Pampa deer (*Ozotoceros bezoarticus*), which weighs only 30 kg. In the neighbouring open Pampas, the faunal contingent is completely different, with many more large ungulates (including guanaco and Pampa deer in large numbers), American ostrich ("ñandú" [*Rhea Americana*]), and medium to small sized rodents adapted to the steppe

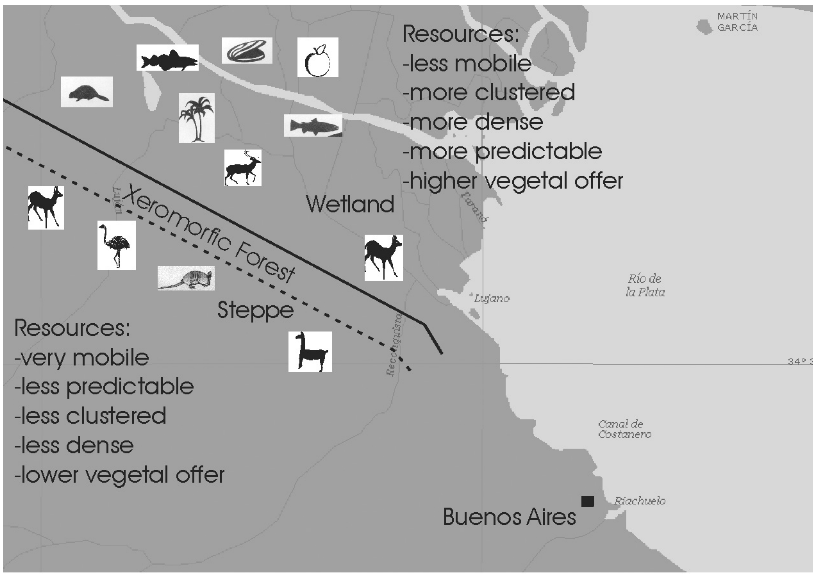

*Fig. 4. Types of resources in the study area according their location of occurrence. Wetlands include a great variety of fishes, coypu (*Myocastor coipus*), cavy (*Cavia aperea*), pampa deer (*Ozotoceros bezoarticus*), marsh deer (*Blastocerus dichotomus*), mollusks (*Diplodon *sp.), palmera de pindó (*Syagruss romanzzhofiana*), and a mix of marginal forest and xeric species in the TATZ. Steppe areas include ñandú (*Rhea Americana*), small rodents (*Chaetophractus villosus *and* Lagostomus maximus*), pampa deer (*Ozotoceros bezoarticus*), and guanaco (*Lama guanicoe*).*

environment (Fig. 4) (*Chaetophractus villosus* and *Lagostomus maximus*).

In terms of plant foods, the wetlands have typical marginal forest communities that are found along the Paraná margins, including many xeric and subtropical plants such as palms. A narrow but compact band of xeric forest on the western border separates the wetlands from the open Pampa. Both communities contain woody and edible species. The neighbouring Pampas grasslands are absolutely devoid of trees (Cabrera 1968).

The Ethnographic Record

The width of the Río de la Plata estuary attracted early European explorers, particularly those searching for a path from the Atlantic to the Pacific Ocean. Others, however, felt that the waterway might provide access to interior Peruvian mines. The first expeditions that navigated the Atlantic entered the Paraná wetlands and recorded a way of life not yet modified by European contact, being far from the first factories in the Caribbean, Peru, or the northwest of South America. The earliest ethnographic sources available for the Lower Paraná wetlands were generated by the expeditions of Fernando de Magallanes (1520), Sebastián Gaboto (1526–1530), Diego García de Moguer (1526–1530), Pero Lopes de Sousa (1530–1532) and Pedro de Mendoza (1535). By the last of these, Spanish colonisation and modification of the local aboriginal way of life was in full swing. Fernández de Oviedo and Valdés personally contacted most of the people on these expeditions and produced a synthetic work of ethnographic observations in the Americas from 1516-1531 (Fernández de Oviedo and Valdés 1944). A later researcher, Antonio Herrera, produced a useful synthesis of diaries and chronicles (some of which now are lost) generated during this first stage of exploration of South America (1601–1615 AD), though he did not conduct direct interviews.

Argentinean scholars have made use of these historic sources since the second half of the 19th century, yet different perspectives exist on their validity and accuracy. The various written sources do not always agree in their observations. As a result, such texts are better used in hypothesis formulation than as explanation. This is particularly true for discussions of ethnic groupings or aboriginal behaviours. Such observations should be posited as “most probable scenarios” and subsequently tested against the archaeological record.

One interesting aspect of sixteenth century Spanish records is the ethnic diversity described for the Paraná wetlands, particularly compared to the ethnic homogeneity and relatively low demographic density of the adjacent open Pampa (Fernández de Oviedo 1944, documents in Madero 1939, Schmidl 1948). This contrast is evident in Fig. 5. It is clear that the ethnic nomenclature used in European descriptions is Guaraní. Spanish and Portuguese expeditions included Guaraní people in their expeditions to the Brazilian coasts and regularly came into contact with Guaraní groups settled in the Lower

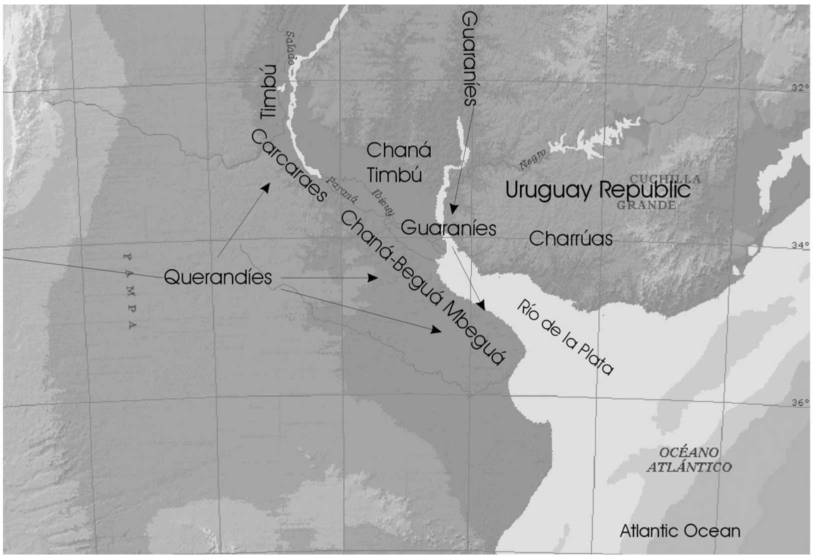

Fig. 5. Ethnic groups documented within the region in the first half of the 16th century.

Paraná wetlands. Moreover, some Spaniards cohabited with Guaraní groups following the first Solís expedition to the area in 1516, learning the language and ethnic distinctions of the Guaraní. It is probable that the use of Guaraní-Spanish bilingual individuals was in part responsible for the "fine grain" of the ethnic picture within the wetlands. In 1582, two years after the second founding of Buenos Aires on the Río de la Plata coast, the broader ethnic map became more accurate as Spanish ethnic designations incorporated non-Guaraní categories to identify other small bands inhabiting the wetlands.

Cast of Characters: The Groups

Amazonian Horticulturists

Guarani groups originated in southern Brazil some 4000 years ago (Migliaza 1982; Schmitz 1991). From there they made a series of long migrations within eastern South America, probably for ecological reasons related to demographic pressure and environmental deterioration. They ultimately spread from the Amazon River basin to as far as the Río de la Plata on the Atlantic Coast and the Peruvian-Bolivian Andes foothills (Brochado 1984). Guaraníes were present (at least) two hundred years before Europeans first encountered the Lower Paraná wetland (Loponte and Acosta 2003).

The Guaraní practised slash and burn horticulture, and in the Paraná wetlands historical records indicate they cultivated primarily maize. Other tropical plants do not grow well in the colder Pampa. Their social structure included patrilineal lineages that inhabited large residences. Villages consisted of hundreds of individuals under a chief with effective power over that group. Ritual cannibalism was practised and slaves were taken from defeated enemies.

Some chronicles distinguish "Guaraníes from the islands" from the "continental Guaraníes" of Paraguay and Brazil. Island Guaraníes did not have access to the continental coast of the Paraná, which may indicate that they preferred the islands as a productive locale, or that they were denied access by those on the coast. Some islands were apparently controlled, with historical records mentioning that specific islands were associated with the names of Guaraní chiefs. However, there is no archaeological evidence of tensions in specific relation to land ownership and rights of access.

Other wetlands groups were using names of Guaraní origin, though in a limited way. This may imply some prestige associated with their use. It is probable that bilingualism (Guaraní-mother tongue) was widespread in the sixteenth century. This situation is consistent with the agricultural expansion model presented by (Mcconvell 2001). Historical European chroniclers mention that, apart from various crops (mainly maize), fishing and hunting were important for these groups, a fact that archaeofaunal and isotopic data tends to confirm (Loponte and Acosta 2003). There are few references to Guaraní technology in the Paraná Delta or Río de la Plata. Only Ramírez mentions that Guaraníes "... bring a lot of metal ... and axes to cut the mountain to cultivate" (Ramírez [1528], in Madero 1939, 384). Such axes are relatively abundant in Guaraní archaeological sites in the Paraná Delta. They are basically bifacially-polished pebbles with or without a neck groove. It is probable that the metal mentioned by Ramírez was obtained through exchange with northern Guaraní groups. Metal sources are extremely remote, implying an extensive exchange web brought them to the Paraná delta. Most chroniclers mention the permanent state of tension and warfare that existed among the Guaraní and the rest of wetlands groups. For instance, Antonio Rodríguez mentions that "these Guaraníes make war with all their neighbours and eat them..." (Rodríguez, in Leite 1948, 174, own translation).

The Hunter-Gatherer Complex

The rest of the groups that were present in the wetlands can be characterised mainly as hunter-gatherers. Most of them, however, incorporated an agricultural component into their economy. The groups identified as ethnic units were the "Chaná-Mbeguá", "Chaná-timbú", "Mbeguá", "Chaná", "Timbú" and "Carcaraes". These hunter-gatherers were characterised by low mobility and year round permanence in the wetlands. Interestingly, both men and women perforated their nostrils and inserted small stones in the holes, and men also perforated their lips and incorporated labrets (locally called "tembetá"). However, there is no good historical or archaeological evidence that the use of these labrets was to mark the specific social status.

Maize cultivation among the Timbúes was more important than for the rest of the groups. Timbúes also stored fish, had a system of ownership of fishing locations, built more substantial dwellings, and maintained a more formalized chief system (Oviedo 1944, 155; Rodríguez in Leite 1948, 174). The Carcaraes, who lived next to the Timbúes, are also noted as mainly fishers. They extracted fish butter and made fortifications for their own defence. On these points the chronicler was probably also referring to the Timbúes. As for the Chaná-timbú and Mbeguá, fish were also important, although some maize cultivation is mentioned as well (Fernández de Oviedo 1944, 154). One citation for the southernmost area of the Paraná, probably referring to the Chaná-Mbeguá, Mbeguá, or Chaná-timbú, mentions the sun drying of fish in preparation for a future lack of food (Alonso de Santa Cruz 1908).

Although these groups are usually described as having a fundamentally hunting and fishing economy supplemented by cultivation (mainly maize), some early travellers refer to them as solely hunter-gatherers lacking cultivation. It is possible that these inconsistencies point to an initial stage in the adoption of the agricultural practices in the sixteenth century. Chronicles mention that, while having different languages, all hunter-gatherer groups could communicate. We do not know if this due to language differences ultimately being minor or if they had a lingua franca.

Hunter-Gatherers from the Hinterland

An entirely distinct group of hunter-gatherers in the area were the Querandí. They are identified as very mobile hinterland groups that approach the wetlands to exploit its resources. The only historical data that attest to the season of presence of the Querandí on the Río de la Plata coast (prior to the establishment of Spanish settlements in the area), places them there in March 1536, coinciding with the first founding of Buenos Aires (Schmidl 1948). The month of March is the end of summer in the southern hemisphere, and the hot season coincides with the highest density of fish resources in the area (cf. Tablado et al. 1988). Although this same chronicler mentions that the Querandí used to move into the interior during summer, he probably was referring to the boreal (northern hemisphere) summer, that is, the south hemisphere winter.

Shortly after the founding of Buenos Aires, a conflict erupted between Europeans and Querandí, because the latter stopped providing food ("fish and meat") to the recently founded fort (Schmidl 1948). When the European party defeated a number of aggregated Querandí bands near Buenos Aires, the Germans and Spaniards soldiers occupied a nearby Querandí village, where they found "a lot of fish", "fish butter", "fish flour", nets and "otter" (coypu) leather (Schmidl 1948). This list of foodstuffs points to the importance of fish for the Querandí and indicates storage through drying and grinding to increase the period of time over which the fish would be available. Moreover, the chronicler states that the village was located near "good waters for fishing". The Europeans occupied the Querandí village for a span of two months, until the beginning of autumn, when fish resources typically decrease. In general we do not know the amount of foods typically provided for the Spanish by the Querandí. Mendoza's army of about 1800 men was badly organised and the loss of even a small amount of provisions from the Querandí may have had an inordinate impact on the European fort. The provision of resources by the Querandí does however indicate the existence of some surplus, perhaps specifically to be exchanged for other goods and services.

The initial confrontation mentioned above was actually quite hard on the Spaniards, who lost about 40 men among the gun infantry and some mounted riders. The losses incurred by the Spanish reflect the high degree of preparation and organisation of the Querandí for the combat. Additionally, during the battle, the Querandí showed a combat order, implying some a formalized order of command perhaps indicative of a paramount chief. Four thousand aboriginals are reported as having fought in combat against the Imperial Army, as the Querandí "have called upon their friends". This number may be exaggerated, and it seems to be designed to impress Europeans readers. The more probable scenario is that the more than 350 European soldiers of the squadron faced a small coalition of many Querandí bands or a multiethnic force, perhaps already aggregated for other purposes.

Archaeological field studies indicate a very high site density but no centralized focus to the settlement pattern in the wetlands between 1700 and 690 BP. This pattern is probably related to the fact that wetland resources are more or less homogeneously distributed throughout the environment. That populations were high year-round in the wetlands (according to chronicles) does not mean that the Querandí had limited access to the area. In December 1531, Pedro Lopes de Souza found near present day Baradero city a small (hunting or fishing?) party of Chaná-Mbeguá who informed them that the lands in that area were Querandí. This implies a use of Querandi lands by others and vice versa. In fact, borders were probably permeable for other hunter-gatherers.

The ethnographic record describes Querandí bands in the interior of the Pampa plains as small and very mobile, following the main species available in the steppe – guanaco and Pampa deer (Fernández de Oviedo 1944; Luis Ramírez in Madero 1939). Spanish incursions into the hinterland Querandí territory found deer and guanaco present, but the area was almost devoid of human population, with "isolated houses, one deviated from the other" (Fernández de Oviedo 1944, 139).

Querandí in the wetlands seem to exhibit low mobility, surplus production, storage, higher demographic density, and possibly hierarchical political organisations that operated in the event of in the case of war, aggregation and/or interethnic alliance behaviours, use of a greater range of edible resources, large quantities of pottery (all wetlands deposits after 2500 BP have large numbers of sherds), specialised artefacts for fishing, and settlement in the high fish resource concentration zone. They also hunted ungulates in the plain. All these data suggest a rather stable residential base system in the wetlands complemented by logistical parties dispatched to the Pampa plains.

Exchange and Alliance

The Querandí territory extended westward toward the interior, bringing them into regular contact with agricultural societies influenced by Andean societies. This allowed the Querandí to have an advantageous position in exchanges between those societies and the groups settled in the Paraná wetlands. They exchanged guanaco leather, knitted containers, and "different kinds of blankets" (probably from Córdoba or Santiago del Estero in the centre of Argentina with well established farming societies) with Carcaraes and/or Timbúes in the wetlands. Furthermore, the existence of "cotton" (probably animal hair) cloths among Querandí women (Fernández de Oviedo 1944, 155) indicates exchanges with cattle-raising societies. It is evident that these exchange mechanisms were completely prehispanic and involved all ethnic groups in the wetlands. In this way, movements of the Querandí to the wetlands may be related to both the structure of resource exploitation inside their territory and the expectation for exchange of goods, people and information in the wetlands. The organizational pattern of the Querandí demonstrates great flexibility in their social organisation and economy, as well as a complex web of alliances and exchange relations that connected groups of very different technological and economic organization.

The Archaeological Record of the Wetland

The Hunter-Gatherer Complex

In this section we provide a brief synthesis of some of the properties of the archaeological record of the southern portion of the Lower Paraná wetlands (northeast Buenos Aires Province, South Entre Rios Province). Sites discussed in the text are shown in Fig. 6. Additional faunal data for these sites including assemblage sample size, taphonomic state, anatomical representation, and specific points of resource exploitation may be found in Loponte and Acosta (2003c) and references cited therein. The sites discussed here range in age from 1700 to 500 years before present, covering a period of about 1200 ^{14}C years. Some deposits have not yet been dated, but based on geomorphologic observations are not older than 2000 years. The absence of European materials and exotic fauna, place them before European colonization of the area in the first half of the 16th century.

All archaeological deposits were contained within in an A soil horizon with an average thickness of 50 cm. Underneath was an archaeologically sterile C horizon that represents the fluvial deposition period in the area (Parker and Marcolini 1992). Excavation was conducted in arbitrary 5 cm levels within the A horizon. Each matrix was sieved through 5 mm mesh. The sieving was initially dry in the early 1990s, whereas in the later years we used wet methods that included flotation and recovery with 1 mm mesh. This has generated a bias in the recovery of finds, especially for cricetid bones, charcoal, microfragments of neural spines of fish, and carbonised seed fragments.

Despite excavation in fine-grained levels, stylistic or technical variations in pottery and artefacts are not evident within individual sites apart from some differences that may be attributed to taphonomic factors. In the same vein, there are no habitation "floors" recognised, and in some cases sherds recovered from different levels belong to the same ceramic vessels. This situation requires presenting data from each site as an aggregated assemblage. Studies in progress on seasonality of seeds and the analysis of the contents of total nitrogen in bones should ultimately allow us to determine if the 50 cm (on average) A horizons represent large and unique discard events, with few or no episodes of reoccupation.

The Lower Paraná wetlands have a high density of archaeological sites (Caggiano 1984). Fig. 6 shows only those sites for which good information was available; there are many more that are not well reported or published. All sites have burials. In some there exists a

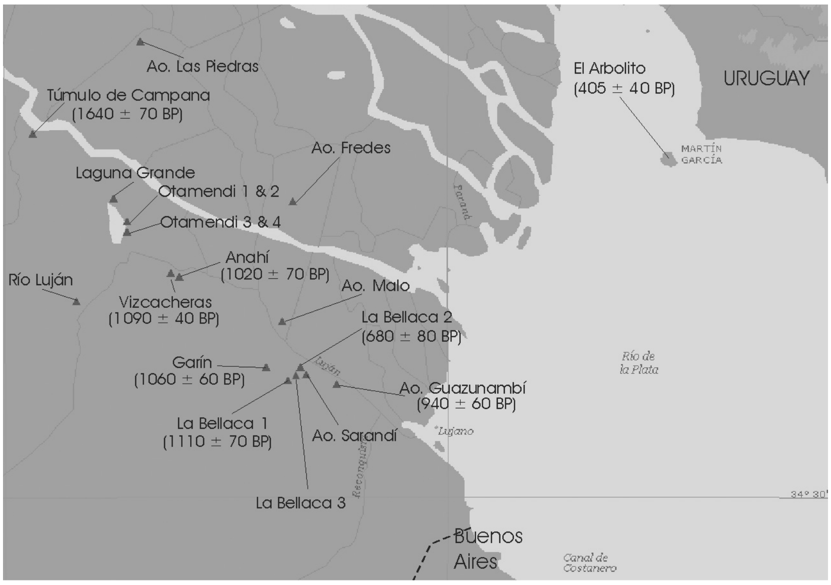

Fig. 6. Distribution and ages of archaeological sites discussed in the text.

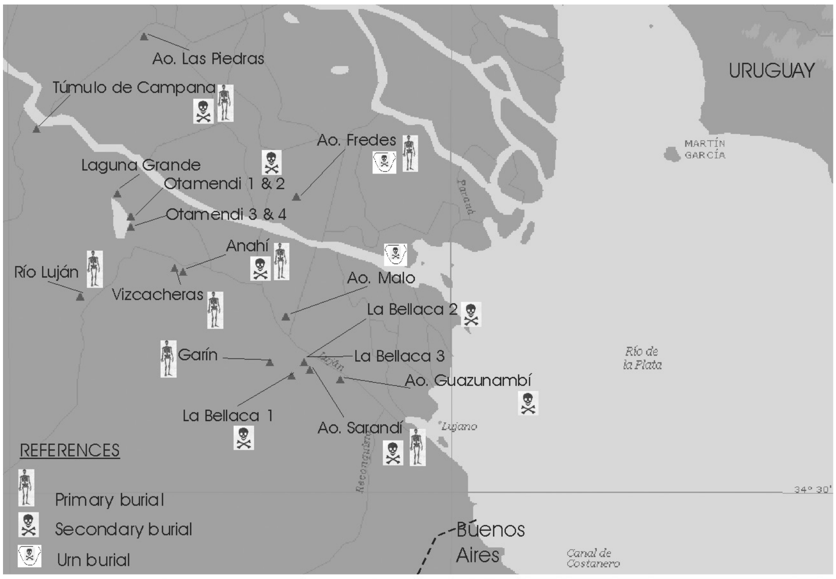

Fig. 7. Types of burials associated with sites in the study region.

clear separation of inhumations from the rest of the habitation area. The types of burials identified at each site are depicted in Fig. 7. Since the beginning of archaeological research in the area (Zeballos and Pico 1878) many hunter-gatherer burials have been excavated. We have summarised about 140 burials, including published information and those resulting from our own excavations. Existing burial data provide no solid evidence for the presence of hierarchical social structures or marked differences in status. The reason behind the existence of primary and secondary burials is not currently clear; more analysis is warranted. Burials in urns are associated with the Guaraní, and these interments sometimes contain offerings (Loponte and Acosta 2003; Lothrop 1932). Hunter-gatherer burials seldom contain offerings, and when they do these are limited to teeth or shell pendants that are also found regularly in archaeological deposits. The significance of some faunal remains found in graves is still a matter of discussion, since most of burials were found in domestic places and, in general, were excavated without taphonomic studies. It is therefore not clear if faunal material is in fact associated with

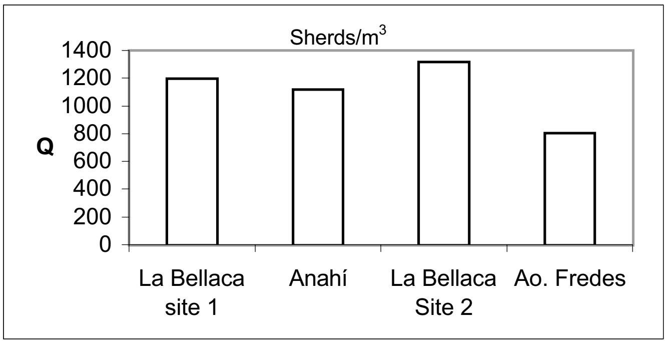

Fig. 8. Density of pottery sherds per cubic metre for select sites: Laguna La Bellaca 1 and 2, Anahí, and Arroyo Fredes.

burials. Analysis of lifeways from human bone has only recently begun (Acosta et al. 2000) and there are not enough isotopic data available at present to evaluate differences in diet among individuals. But neither is this expected to be the case, since ethnographic sources make no reference to status-based distinctions in diet or burial treatment.

The excavated sites identified in Fig. 6 represent multiple activity areas (Loponte and Acosta 2002a, 2002c). All have abundant plain, domestic pottery with charcoal residue on the exterior surface (Fig. 8). Decorated sherds typically lack charcoal deposits. Pottery styles similar in design and technological production were recognized at different sites, allowing the grouping of some of the sites in the region (Caggiano 1984; Pérez and Cañardo 2002; Rodrigué and Magnífico 2002). Despite the identification and differentiation of some styles, there is a basic stylistic and technological pattern that suggests an intense circulation of shared ideas in the wetlands between 1700 and 500 years BP (Rodrigué and Magnífico 2002). Fatty acids analysis conducted on plain sherds from some of the sites has indicated the same acids as some of the Paraná siluriformes, including the granulated catfish (Pérez and Cañardo 2002). As well, the boiling of fish and meat in general seems to be associated with an increase in the range of resources consumed. Handle grinding stones were found in all the sites, and can be linked to the preparation of some kind of dry food.

Additionally, wetland deposits contain varied and specialised equipment for prey capture. Lithic projectile points, bone points (of various morphologies), and composite harpoons made of antler and bone were identified in all sites (Acosta 1998; Loponte and Acosta 2002a; Loponte and Sacur Silvestre 2002). Bola stones (for hunting ungulates in open environments) were also found. Fishing nets are described in ethnographic accounts, and also may have been used in the capture of mammals from both water and land environments. There is virtually no mention of the existence of traps, however. Nevertheless, the careful design of the composite harpoon points in particular suggests a high work investment in hunting technology (Loponte and Sacur Silvestre 2002). The existence of various harpoons with smaller gradations from an initial form suggests an intense maintenance and reworking process of implements broken during use. Interestingly, identical harpoons are found in deposits that contain very different pottery styles, and harpoons have variable incised marks with very precise designs, different from pottery and suggestive of property marks.

The lack of suitable rock sources in the lower Paraná wetlands should be taken into account when considering the cost of obtaining (by logistical movement and/or exchange) raw material to produce grinding and bola stones and lithic projectile points. Pebbles in the Uruguay River, some 160 km away, probably represented the closest source. Cuarcite veins also exist in the vicinity of that river, but the quality is quite poor. Good quality cuarcite is found in many sites in the wetlands, but is derived from outcrops in the interior of the Pampa plains more than 400 km away (Sacur Silvestre 2002). The lack of local rocks for knapping fostered the extensive use of bipolar knapping techniques in the area.

Significant differences are apparent in the quantities of rock recovered among the sites. Microflakes and nuclei (cores) are lacking entirely in some sites, but these sites often contain finished projectile points. In these cases, it has been suggested that these lithic points may have entered the sites already finished (Loponte and Sacur Silvestre 2002), probably through exchange. In other deposits with more quantities of lithics, the assemblages are dominated by small flakes without retouched edges. Analyses of flake edges under high (electronic microscope) and low (metallographic microscope) magnification have identified use wear on numerous edges (Sacur Silvestre 2002).

Faunal exploitation was centred on fish, which seems to have provided a larger amount of biomass (around 50%) than ungulates (for an analysis of the different sites, see Loponte and Acosta 2002a, 2002b). There is a tendency for greater reliance on fish resources during summer, although this pattern must be corroborated

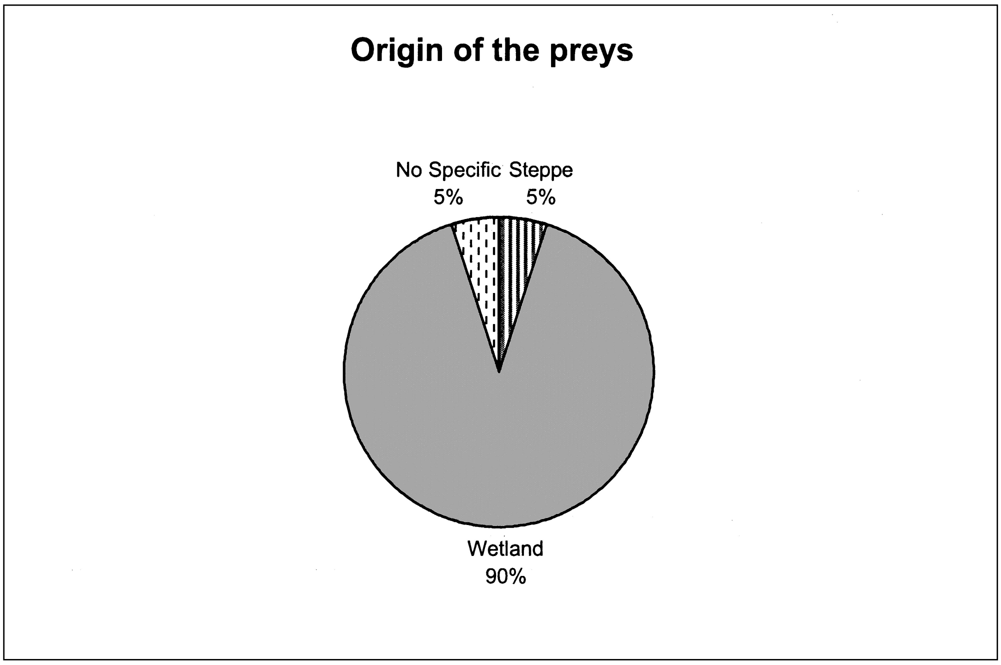

Fig. 9. Ecological origin of hunted animal species, averaged for all sites in Figure 6.

further. The most consumed fish species was *Pterodoras granulosus* (granulated catfish). Significant consumption of some Characiformes species is also evident (Acosta et al. 2002). Recovered bones of granulated catfish have a specific and unique pattern of representation. Around 20% of MAU corresponds to crania and 10% to the appendicular skeleton, whereas the body has 100% representation. This pattern has been identified as evidence of delayed consumption by many authors (see discussion in Acosta et al. 2002). It has been rejected that this representation results from fragmentation, identification problems, or bone density of *this particular catfish,* which has very strong bones in the crania (Acosta et al. 2002). Also, if the preparation of fish flour included grinding of bones, NISP/MNI values would be very underrepresented for *other* fishes as well, specifically for the Characiformes, which comprises almost 70% of Paraná and Río de la Plata ichthyic biomass (see discussion in Acosta et al. 2002 and Musali et al. 2003). Bone mineral density analysis (tomography-computed) of fish bone (Characiformes and Siluriformes) and their anatomical representation in archaeological sites show no correlation (Acosta et al. 2002).

However, there is a clear problem with the identification of the Characiformes. Recent x-ray studies of fish vertebrae collections show a higher percentage of Characiformes than Siluriformes vertebrae. This could mean that diagnostic Characiforms bones are missing or never entered the sites and that fish exploitation was broader than previous analyses have shown. Rodent (coypu and cavy) hunting was also important, and these two species provided around 20–25% of the total consumed biomass. Ungulates (marsh and Pampa deer) have a smaller percentage representation than rodents, although the importance of large mammal hunting is more significant because of the use of antler in the production of harpoons. Fresh water mollusc consumption seems to be variable (Bernal 2002).

Fig. 9 shows the origin of hunted animal species, averaging the sites in Fig. 6 in relation to sample size and MNI. The small percentage of bones derived from taxa typical of open environments (rolling Pampa) consists mainly of ñandú (*Rhea americana*) and guanaco (*Lama guanicoe*). The anatomic representation of the latter is markedly different in relation to the rest of the hunted ungulates (Pampa deer and marsh deer). Guanaco is exclusively represented by phalanges and distal metapodial fragments. This is interpreted to represent the final stage of leather processing (Loponte et al. 1998; Loponte and Acosta 2003b). Such representation may be indicating exchange with Pampa plain groups, mobility from the steppe to the wetlands, the use of logistical parties to exploit the steppe with residential bases remaining in the wetlands, or a combination of these strategies.

The Guaraní Archaeological Record

Archaeological knowledge of this horticultural group is very scant for the area (cf. Lothrop 1932; Cigliano et al. 1971). New data obtained from the excavation of the

Arroyo Fredes site located in the island area of the wetland shows a pattern influenced by its insular situation (Loponte and Acosta 2003). Fishes, marsh deer, coypu and "capybara" were the main sources of animal protein. The "capybara" (*Hydrochaeris hydrochaerus*) is the largest rodent in South America, weighing upwards of 60 kg. It is extremely rare or absent in hunter-gatherer sites. Salemme (1987) has suggested this absence may be due to some kind of symbolic restriction against consumption of this animal among the local hunter-gatherers. Exploitation of this large rodent by the Guaraní was, in contrast, common and systematic.

Guaraní pottery is completely different than that of the local hunter-gatherers, mainly in that it is corrugated (finger printed), nail printed, and polychrome. (Rodrigué and Magnífico 2002; Loponte and Acosta 2003). The technology and shapes used are quite distinct also, and volume capacities are larger than among hunter-gatherers. All lithic raw material recovered seems to have been obtained from oriental sources along the Uruguay River, contrasting with the interior continental sources (western) used by hunter-gatherers in the area (Loponte and Sacur Silvestre 2002; Sacur Silvestre 2002). Polished axes made of fluvial pebbles (probably used to clear areas for cultivation and also for disarticulation of big prey) are a distinctive typological type of the Guaraní. Bipolar percussion on the nuclei (in this case, river pebbles) was used to obtain flakes that were employed unretouched as knives, a technology that is also part of hunter-gatherer lithic assemblages. The only projectile point recovered at Arroyo Fredes has the same design as hunter-gatherer points, but is larger. Only one piece of metal (bronze) was recovered, but further taphonomic and analytical studies are needed in order to establish the antiquity of this artefact.

Burials were in urns, with skeletons disarticulated and usually covered with ochre (see Lothrop 1932). The biological population of the Guaraní appears overall shorter and more gracile than hunter-gatherers, but this remains an anecdotal observation. The Guaraní archaeological record also contains larger settlements. Hunter-gatherer sites average 1400 square meters in size, while Arroyo Fredes covers at least 10,000 square meters.

Isotopic Study of Diet

Stable isotope analyses have been undertaken in order to illuminate patterns of resource consumption among groups inhabiting the Paraná wetlands. Fig. 10 shows all available isotopic data for prey and humans in the wetlands (a more detailed discussion of the analyses of isotopes obtained from the area can be found in Acosta and Loponte [2002]). The lack of significant isotopic fractioning in humans compared to their prey and the spacing of organic versus inorganic collagen suggests a significant plant food component in the diet. Overall, this amounts to close to a 30% contribution to the total diet, with some important variations that will be discussed below.

The only recovered macroscopic evidence of plant food consumption corresponds to burned Pindó seeds, a date-palm (C_3) common in the wetlands. Remains of this seed are found in abundance in all archaeological sites. A radiocarbon date obtained on burnt seeds recovered at the Las Vizcacheras site is identical to an AMS age obtained from a guanaco phalanx from the same deposit (Fig. 3). Moreover, analysis of phytoliths preserved in

Lab.	Samples	Sites	Sex	Chronology	Organic fraction		Inorganic fraction		Spacing
				δ^{14}C YBP	δ^{13}C(o/oo)	δ^{15}N(o/oo)	δ^{13}C(o/oo)	δ^{18}O(o/oo)	δ^{13}C co-ca
LP-1401	Pindó seeds	Las Vizcacheras		1070 ± 60	- 25 ± 2 o/oo	n/d	n/d		
Beta 148237	Guanaco	Las Vizcacheras	n/d	1090 ± 40	-18,6	n/d	n/d		
UGA # 9905	Coypu	Garín	n/d	1060 ± 60	-17,63 ± ,09	4,30 ± ,12	-10,16 ± 0,1	-2,83 ± 0,1	
UGA # 9906	Doradidae (fish)	Anahí	n/d	1020 ± 70	-17,69 ± ,15	5,50 ± ,05	-6,97 ± 0,3	-3,87 ± 0,1	
UGA # 9907	Marsh deer	Anahí	n/d	1020 ± 70	-20,30 ± ,01	6,01 ± ,19	-10,33 ± 0,12	-3,38 ± 0,1	
UGA # 9908	Pampas deer	Guazunambí	n/d	940 ± 60	-18,80 ± ,02	5,23 ± ,02	-9,27 ± 0,1	-0,68 ± 0,1	
UGA # 9909	Pimelodidae (fish)	Garín	n/d	1060 ± 60	-18,09 ± ,04	6,11 ± ,20	-9,43 ± 0,8	-3,28 ± 0,1	
UGA # 8780	Human	La Bellaca S1	female	1170 ± 70	-18,75 ± ,03	9,07 ± ,30	-11,14 ± 0,1	-3,35 ± 0,1	7.61
UGA # 8781	Human	La Bellaca S2	male	680 ± 80	-18,51 ± ,4	9,49 ± ,06	-11,06 ± 0,1	-3,95 ± 0,1	7.45
UGA # 8782	Human	Anahí	male	1020 ± 70	-19,34 ± ,47	8,17 ± ,15	-11,42 ± 0,1	-3,94 ± 0,1	7.92
UGA # 8783	Human	Garín	male	1060 ± 60	-16,85 ± ,3	8,89 ± ,03	-9,95 ± 0,1	-4,11 ± 0,1	6.9
AIE 12366	Human	Ao. Sarandí	male	n/d	-20,3 ± 0,3	n/d	n/d	n/d	
AIE 11725	Human	Arroyo Malo	male	in process	-15,20 ± ,20	n/d	10,20 ± 0,1	-3,9 ± 0,1	5
AIE 12364	Human	Arroyo Fredes	male	in process	-15,1 ± 0,3	n/d	n/d	n/d	
AIE 12365	Human	Arroyo Malo	male	in process	-15,2 ± 0,3	n/d	10,1 ± 0,2	-3,3 ± 0,1	5.1

Fig. 10. Stable isotope values for prey and humans in the Lower Paraná wetland.

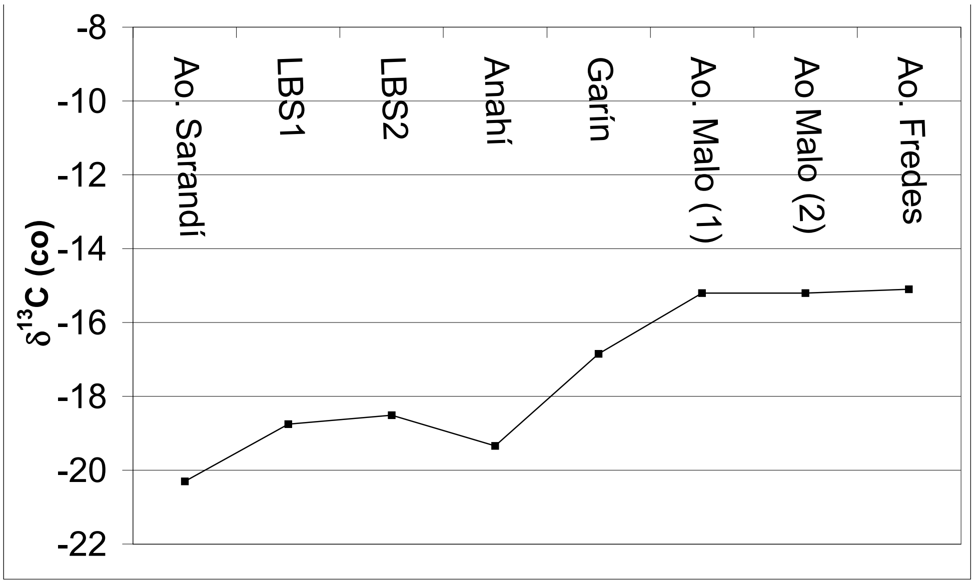

Fig. 11. Stable carbon isotope values illustrating differences between a horticulturalist diet including C_4 photsynthetic pathway plants (Arroyo Fredes and Arroyo Malo sites), a hunter-gatherer diet based on C_3 pathway resources (Anahí, LBS1, LBS2 and Sarandí), and an intermediate value from a mixed hunter-gatherer context (Garin).

human dental tartar of both hunter-gatherers and horticulturalist has shown siliceous components of the family of this palm, as well as other C_3 plants (Pau 2002). The δ^{13}C values obtained from hunter-gatherer skeletons (Fig. 10) indicate a C_3 photosynthetic pattern that includes both prey and edible species of the xeromorphic forest that separates the wetlands from the rolling Pampa and subtropical forest of the Paraná River.

In contrast, individuals recovered at Guaraní sites show a predominantly C_4 photosynthetic pathway consistent with the consumption of maize (Fig. 10). The δ^{13}C spacing, however, suggests that the hunting component of their diet was more important than in hunter-gatherer groups, who had a greater (wild) plant food component in their diet than did the horticulturalists (maize). This situation may reflect the difficulty of access for the Guaraní to the strip of xeromorphic forest west of the wetlands, an area previously occupied by hunter-gatherers. This forest had the most varied and concentrated plant food contingent in the area. This lack of access may have to do with territorial defence by hunter-gatherers or may simply be a result of economic decisions amongst the Guaraní themselves. In any event, the isotopic values underscore the importance of plant foods in autochthonous prehistoric populations (Fig. 11).

In summary, individuals showing a C_3 pattern are hunter-gatherers with a significant level of consumption of wild plants. The possibility of some minor cultivation of a C_3 plants by hunter-gatherers should not be discarded, but no evidence of this has yet been identified. Individuals with a C_4 patterns are solely individuals from Guaraní burials. The exception to this distinction is the skeleton from the Garín site, which produced an intermediate value. This site has been recorded as generated by hunter-gatherers (Loponte and Acosta 2002a). The δ^{13}C could then be signalling the early consumption of maize by these hunter-gatherers, perhaps obtained through exchange with Guaraní or perhaps other northern groups (i.e., Timbú). It may also reflect some maize horticulture by hunter-gatherers 500 years before the ethnographic picture of the sixteenth century. However, because this is only one anomalous value, more analyses are needed.

A Picture of the Lower Paraná Wetlands in the Late Holocene

Fig. 12 summarizes the cultural features of the archaeological record of hunter-gatherers in the wetlands, as well as those aspects mentioned in the historical texts. Most behaviours and/or features necessary to support an argument for cultural complexity are present. There is, however, virtually no evidence of social hierarchies within these hunter-gatherers. Currently, there is no good archaeological or historical evidence of storage behaviour resulting from exchange alliances. Rather, hydrologic irregularity is a fact of reality in the wetlands, and storage appears directed toward facing that risk.

The same technological process of pottery production, similarities in projectile points design, identical body ornaments, raw stone material usage, and subsistence

Population density and mobility	**high population density (*)**
	low residential mobility (central place foraging); logistical task groups (*
	large residential groups
Social organization	social hierarchies (?)
	interethnic rituals
	interethnic alliances (*)
	hereditary status
Economy	**intensive exploitation of select resources (*)**
	storage (*)
	trade and/or exchange (*)
	occupational specialization
Property and Territoriality	**ownership of resources (*)**
	active defense of territories (in some cases) (*)
Technology	**pottery production at a significant scale (*)**
	stylistic variability in pottery (*)
	sophisticated extractive gear, with high technological variability (*)
Symbolic aspects	**burial areas (*)**
	prestige goods (?)

(*) Identified properties (archaeological and/or ethnographic)

Fig. 12. Cultural features of the archaeological and/or historical record of hunter-gatherers in Lower Paraná wetland.

activities suggest the existence of an integrated hunter-gatherer social system across the wetlands, involving many groups with an overall high population density and low mobility, exchanging goods and information in a significant way. These groups also developed an exchange system that included the hinterland (and probably the southern coast of the Río de La Plata and beyond). This integration tends to homogenise the hunter-gatherer archaeological record of the region. In contrast, specific pottery styles point to some distinctions and boundaries.

It is clear that pottery production, exploitation of fish resources, storage, and delayed consumption were well-established behaviours among hunter-gatherers of the area. Plant foods were also important. The intensification of fish and plant food harvesting was probably the most significant part of the subsistence strategy, which does include a broader though less significant set of resources such as ungulates and medium to small rodents. Technological equipment includes a variety of devices to capture and transform energy obtained from the environment. Low mobility and ownership of some resources (fishing locations and horticultural fields) presents a number of organizational issues among these populations. One result was probably the active defence of territory.

A more flexible pattern is indicated for the Querandí, who alternatively exhibit behaviours similar to foragers in the steppe and another closer to collectors in the wetlands. This suggests different strategies arising from social and environmental circumstances. Military-based hierarchical power structures may have developed quickly within this group as a response to the European invasion or perhaps also against pressure arising from Guaraní incursions. It is remarkable that social hierarchies are absent despite the existence of these leadership behaviours.

An Agenda for Lower Paraná Wetland Archaeology

Over the last five years our knowledge of the archaeological record of the Paraná wetland has changed drastically, though on the whole it remains poorly understood. The middle or early Holocene is yet unknown, but will be critical for understanding the late Holocene situation.

The arrival in the area of Guaraní groups in canoes could have been a trigger for more complex behaviours in hunter-gatherers population in the wetlands, primarily because it probably would have increased competition for space and resources. For instance, historical documents mention that Guaraní owned several of the islands in the lower Paraná (see Loponte and Acosta 2003). One of the crucial topics to investigate in the future is whether small-scale horticulture and complex behaviours were generated by long-term, local processes that had commenced before the arrival of these Amazonian groups. The characteristics of the Túmulo de Campana site (1640 ± 70 BP) suggests that the process leading to complexity had started by at least 2000 BP, a date too early to coincide with the arrival of Guaraní groups in the area.

Evidence suggests few links between horticulturalists and hunter-gatherers. The exploitation of different sources of lithic raw material indicates that parallel exchange webs existed with little connection between them. Moreover, in Guaraní sites there is no record of pottery typical of hunter-gatherers, and vice versa. Hostilities between Amazonian horticulturists and hunter-gatherers described in historic records may have deterred the formation of alliances. An important issue to explore in the future is whether the insular situation of the Guaraní was a result of choices as to where to settle or whether it was a product of hostilities with hunter-gatherers.

Archaeological data hint at two processes of development between 1700 and 500 BP. First, a diversity of subsistence pursuits gave way to an increased focus on fishing (and perhaps plant foods). Second, there appears to be a progressive increase in the use of pottery (Pérez and Cañardo 2002), possibly reflecting an intensification of food production or increase in the spectrum of foods consumed.

Finally, the relationship between the Paraná wetland and the Pampean plains of Uruguay during the entire Holocene is still a substantial chapter in the archaeology of the area that needs to be addressed, as does the process of human colonization and evolution in the wetland during the middle and late Holocene. Tackling these major issues will make for an exciting agenda for the archaeology of the area in the future.

Final Remarks

In the Holocene the last habitable areas of the world were colonized by hunter-gatherers (Bettinger 2001; Binford 2001). Complex hunter-gatherer societies are common in the Holocene in many parts of the world (Lourandos 1985; Price 1995, Smith 2001). In contrast, truly complex hunter-gatherers are absent in the Pleistocene (a different view can be seen in Feinman 1995 or Hayden 2001).

The global trajectory fuelling complexity looks like a process related to population growth and circumscription that fuels competition for resources. But is also reasonable to consider that after this initial economic necessity or adaptive opportunity, the pathways to complexity were very variable due to social, natural and historical aspects (cf. Feinman 1995; Smith 2001). It is also probable that rich environments and hunter-gatherer populations are not sufficient features to initiate complex behaviours. It is possible that the properties of the main resources selected by human populations could be extremely important. Human circumscription associated with an economy focused on one or more key resources with a marked seasonality (and critical for social reproduction) also seems critical. A number of other factors come into play, including: localized catchments; a high incidence of plant foods in the diet; resources that are gathered in mass requiring high technological investment and labour coordination. The suite of factors probably constitutes one of the major cocktails of complexity. The most probable outcomes of these factors include lower mobility, an active defence of territory or resource catchment areas, technological specialization, storage and delayed consumption.

The major causes and properties listed above are clearly intrinsically linked. Each one acquires more significance if they operate together, and the magnitude of one has strong consequences for the others. These properties could be seen as behaviours to reduce risk and uncertainty in a complex (social and natural) environment. Later consequences, with very different degrees of regional development, could include the intensification of alliances and exploitation of critical resources, intensification of regional exchange systems, village structuring, and space signalling. The ultimate consequences of the system itself may be food production, social inequality, craft specialization and more complex social roles. As regards human behaviour, all the proprieties assigned to complexity in hunter-gatherers may successfully develop in few generations, so complexity can develop quickly in response to a competitive environment in order to reduce risk and uncertainty.

Specific environmental and historical factors explain the onset of complexity, which cannot be understood as a simple sum of its components. The development of social inequality seems to take root after the initial stages of complex hunter-gatherers. We think that the current understanding of the rise of complexity in hunter-gatherers is poor, and requires more intensive study of archaeological data in specific areas of the world. Moreover, because complexity among humans is a process that can develop quickly but nevertheless probably takes generations, the ethnographic record may not always be a useful tool to help understand the rise of complex hunter-gatherers.

The irregular and rich environment of the Lower Paraná wetlands is one of the major properties of this natural environment. It has two main resources to support high human population densities, fish and plant foods. Both have a peak concentration during summer months. Around 1000 BP, these resources were the main sources of food for the populations of the wetlands, and most of the properties of complex hunter-gatherer societies were well established. High human population density and the intensive exploitation of fish and plant foods were probably closely related with pottery production, lower residential mobility, storage, and the active defence of catchment areas. Within specific wetlands groups, the similarity in pottery techniques, funeral patterns, technological designs, and other stylistic and symbolic expressions indicate the existence of human populations linked in social, technological and symbolic spheres. Hinterland bands provided access for the wetland population to a long distance exchange system that extended to the West, indicating that, while well integrated, this system was open to external interactions.

Acknowledgments

The authors wish to thank Colin Grier for his comments and help with the English translation. Two anonymous reviewers also improved this contribution, but the content remains entirely the responsibility of the authors.

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Daniel Loponte and *Alejandro Acosta*
Instituto Nacional de Antropología y Pensamiento Latinoamericano & Facultad de Ciencias Naturales y Museo
Universidad Nacional de la Plata
Marcos Paz 3136 (1417) Buenos Aires,
Argentina
E-mail: danloponte@sinectis.com.ar
acosta@mail.retina.ar

Javier Musali
Tesista de la Carrera de Ciencias Antropológicas
(orientación arqueológica)
Facultad de Filosofía y Letras,
Universidad de Buenos Aires
Misiones 369 10º A (CP 1083),
Ciudad Autónoma de Buenos Aires,
Argentina
E-mail: jmusali@sinectis.com.ar

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 126–135

10. Affluence on the Prehistoric Northwest Coast of North America

Colin Grier

An abundance of resources on the Northwest Coast of North America supported remarkably complex hunter-gatherers, and consequently environmental productivity has been a central feature in discussions of economics in the region. However, less attention has been paid to the distinction between "affluence" as a social construct and "abundance" as an ecological property. This paper addresses critical issues in the conceptualization of affluence for the prehistoric Northwest Coast, arguing that it must be approached as: (1) a social construct rather than ecological condition, (2) a dynamic that fuelled the construction of economic, social, and political inequalities; (3) promoted by social actors with interests operating as catalysts in the intensification of production, (4) having operated at multiple scales over which production, consumption, and exchange occurred; and [consequently] (5) a more complex phenomenon than an adaptation to ecological circumstances. Recently obtained stable isotope data for the Dionisio Point site provide an empirical basis for operationalising these points in the study of the prehistoric Gulf of Georgia region of coastal southwestern British Columbia, Canada.

Issues in the Conceptualization of Affluence

Discussions of affluence in the study of aboriginal Northwest Coast societies have always been tied to ecological abundance and intensive resource production. Ethnographic accounts of potlatching largess (e.g., Codere 1950) have created an anthropological perception of Northwest Coast societies as extremely wealthy in material terms. While this view may be in some respects a misconception, ethnographic Northwest Coast societies did obtain levels of wealth and affluence unknown to most hunter-gatherer groups. They were thus anything but the "original affluent society" (or OAS) as described by Marshall Sahlins (1963, 1972) in which affluence was based on few wants and needs, balanced reciprocity, and a life of relative leisure and comfort.

Thus relevant to the discussion is the distinction made by Koyama and Uchiyama (this volume) between two quite different conceptualizations of affluence – the Sahlins OAS and the abundance/intensification/complexity model. As they note, these disparate views have guided research into hunter-gatherer socioeconomics over the last couple of decades, and have lead archaeologists in quite different research directions. The study of small scale, materially-modest foragers has focused primarily on their spatio-temporal mechanics, typically involving characterization of archaeological site patterns in terms of the Binfordian-inspired collector-forager distinction (Binford 1980). This approach has treated the social organization of hunter-gatherers as unproblematic and at times epiphenomenal, with the notable exception of investigations of subsistence (re)distribution mechanisms such as sharing. In contrast, research concerned with littoral and other "complex" hunter-gatherers has privileged the study of material affluence and its socioeconomic context, incorporating topics such as inequality, resource intensification strategies, and power. This research realm has intentionally problematised the socioeconomics of these "affluent" hunter-gatherers.

This marked divergence in research has resulted in a division within hunter-gatherer studies between those subject groups where social relations are viewed as the critical problem domain ("complex" hunter-gatherers) versus those (small-scale foragers, typically) where social relations are viewed as stemming directly from basic economic pragmatics in specific (often marginal) ecological contexts. But were these two types of societies, and two "types" of affluence, in actuality fundamentally or qualitatively different? If so, in what specific respects? One answer that emerged in discussions at the "Beyond Affluent Foragers" ICAZ symposium in Durham (on which this volume is based) was that the production, distribution, and consumption of resources may be subject to fundamentally different organizational parameters in affluent, complex hunter-gatherer societies. This is not simply an economic issue, but a social and political one. Amongst small-scale foragers, resource control (including control of labour) is not a central organizing principle. This is not the case among complex hunter-gatherers, where the control of resources has often been advanced as the *raison d'etre* behind the intensified production and inequality that dominates their socioeconomics.

Perhaps also relevant is the observation that a marked difference exists in the dynamics of competition in the two types of "affluent" societies, a point made previously by George Cowgill (1975) and expanded upon subsequently by Brian Hayden (1994, 1995) in a series of more recent papers. They suggest that competition for resources is often *more* intense under conditions of ecological abundance and/or economic surplus than the competition that occurs under conditions of limited resources. I would add that competition over resources in conditions of abundance centres on controlling surplus resources, while under conditions of limited resources competition surrounds risk minimization, and ultimately, survival. These conditions can produce very different type of behaviours, particularly in the motivations for advancing specific socioeconomic agendas, which have a critical affect on resource flows. Moreover, under conditions of affluence the resources that individuals or groups have at their disposal to engage in competitive endeavours is greater. Perhaps nowhere is this more obvious than in the Northwest Coast potlatch. Thus, in affluent societies competition is resource fuelled rather than resource starved.

In this paper I argue that researchers working on the Northwest Coast, as well as those concerned with other complex, highly sedentary and perhaps socially stratified hunter-gatherers (e.g., Jomon Japan [Uchiyama, this volume] and the Chulmun Period in Korea [Kim, this volume]), have qualitatively different social and economic dynamics to confront than those grappling with the ecology of mobile and small-scale foraging groups. My central point is that the development of Northwest Coast societies (and perhaps those of other intensive hunter-gatherers as well) cannot be understood without conceptualizing their economies as political economies, and that the driving force behind the development and construction of these political economies were social actors with specific agendas and interests. It is in this context that we must discuss "affluence".

In order to operationalise these notions, it is important to realize that an economy is ultimately a socially-constituted process involving complex relations among individuals and groups with diverse interests (Halperin 1989; Polanyi 1957). If we fail to address that point, despite the methodological challenges of doing so, we fail to consider some fundamental dynamics in the development of complex hunting and fishing economies and risk reducing our problem domain to the study of the spatial ecology of foragers. I amplify this point below through discussion of an archaeological case from the prehistoric Northwest Coast of the Americas, specifically the Gulf of Georgia region of coastal southwestern British Columbia, Canada, where I have been conducting archaeological research since 1996.

Modelling the Gulf of Georgia Regional Situation

Ethnographic information indicates that during the early historic period (primarily the nineteenth and early twentieth centuries in the region) large regional networks or interaction spheres existed on the Northwest Coast within which resources flowed and people moved (Fig. 1). Donald Mitchell (1971) among others (Ames and Maschner 1999; Grier 2003; Suttles 1990) has noted that the spatial extent of these regional networks closely follows regional stylistic and cultural variability along the Northwest Coast. This correlation is particularly noticeable in art styles, patterns of human cranial deformation, labret use, and burial practices (Donald 2003).

Evidence also indicates that these contact-period social and economic networks had significant time depth, as apparent in their general correspondence with, for example, prehistoric obsidian trade networks between 5000 and 3500 BP (Carlson 1994). These regional networks generally incorporated at least one major river system. Large rivers provided corridors for transportation, interaction, and exchange. It is also along these river systems that we typically see early and pronounced economic intensification (Ames and Maschner 1999; Burley 1980; Carlson 1994; Donald and Mitchell 1994). This situation was likely due, at least in part, to the concentrated and abundant resources rivers offered, most notably anadromous salmon (Donald and Mitchell 1994).

I have been pursuing archaeological research in the Gulf of Georgia, a regional network or interaction sphere that encompasses much of the inner coast of southern British Columbia, Canada, including the Lower Fraser River system (Fig. 2). The Gulf of Georgia constitutes a distinct region geographically and ecologically. Donald Mitchell (1971) has convincingly argued that the region, inhabited historically by the Coast Salish, also displays a distinct ethnological character. Archaeological research

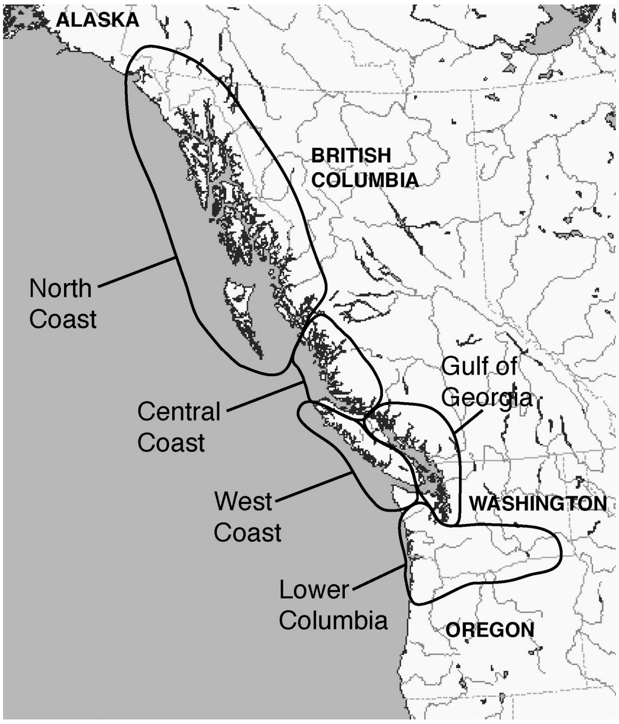

Fig. 1. Approximate extent of regional networks or interaction spheres on the Northwest Coast of North America as they existed during the early historic period (after Ames and Maschner 1999, 168–9).

has revealed this distinct character has existed in certain respects for at least the last two millennia (Brown 1996; Grier 2003; Mitchell 1971). Elsewhere I have argued that by roughly 2000 years ago, during what is known as the Marpole period, the Gulf of Georgia region had developed a staple-financed political economy focused on the resources of the Fraser River (Grier 2003).

My overarching research objective within the region has been to study developments over the last three millennia in order to understand how regional-scale surplus economies develop in conjunction with social and economic inequalities. To accomplish this, it is necessary to consider the various scales at which the regional political economy was organized. What were the basic productive units? How widely and cooperatively did these units operate economically and politically to acquire food and other resources? What was the nature and scale of the political interactions that developed? In my research it has become increasingly clear that answers to these questions must be sought through the analysis of economic, social and political organization at four scales: the entire region, the sub-region, the village, and the household. In this paper I address two of these scales – the household and region – in order to develop some initial answers to the questions posed above.

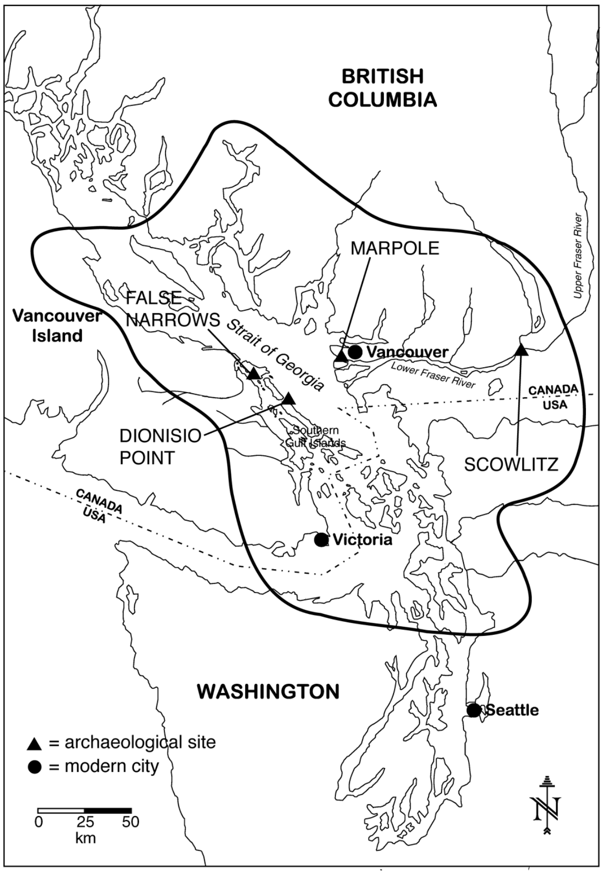

Fig. 2. Approximate extent of the Gulf of Georgia region and location of archaeological sites mentioned in the text.

The Dionisio Point Site in Gulf of Georgia Context

Since 1997, I have undertaken investigations at the household scale through excavation of the remains of a large plankhouse at the Dionisio Point village site in the Gulf Islands of coastal southwestern British Columbia, Canada (Figs 2 and 3). The village site dates to roughly 1700 – 1400 BP (Grier 2001:117–130). The objective of these excavations was to determine what one multifamily co-residential group (i.e., household) was producing and consuming in terms of resources, how wide was its reach in acquiring those resources, what level of affluence it achieved, and whether this wealth was distributed evenly among household members.

It is now clear that the household investigated at Dionisio Point operated at a regional scale to acquire resources and participated in regional interactions and exchanges with mainland Fraser River groups. Two stone bowls recovered from the house share stylistic affinities with a widespread tradition of stone bowl sculpture found in significant numbers throughout the Gulf of Georgia,

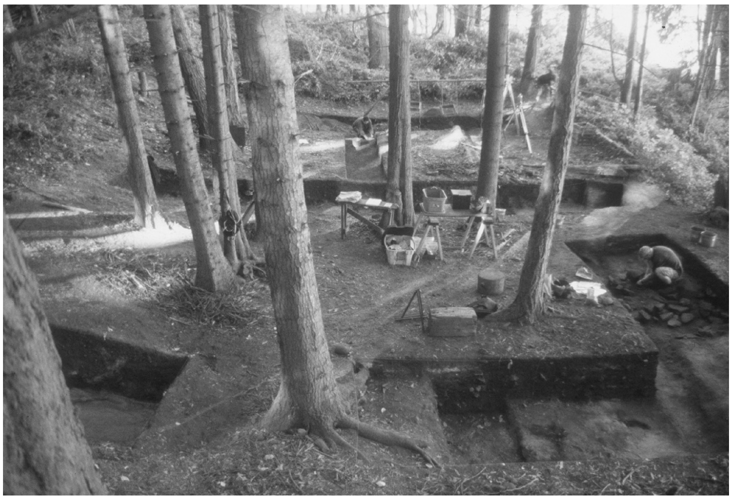

Fig. 3. Excavations in House 2 at the Dionisio Point site, 1998.

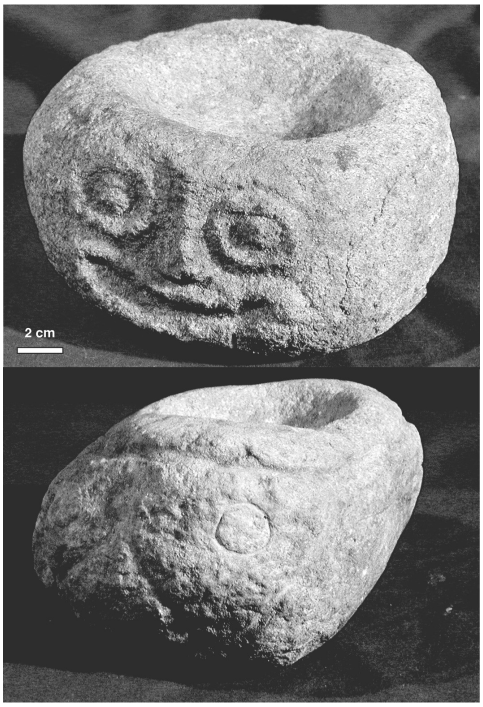

Fig. 4. Ritual-related stone bowls recovered from House 2 at Dionisio Point.

though most commonly along the Lower Fraser River (Fig. 4). The consistent iconography of Marpole stone sculpture has been used to argue for the standardization of symbolic representation systems and ritual practice throughout the region (Duff 1956; Grier 2003). Other cultural practices, most notably burial mound design, also become standardized throughout the Gulf of Georgia region after roughly 2000 BP (Brown 1996; Thom 1995). The existence of a shared system of symbolism throughout the region is complemented by evidence of long-distance economic interactions. By the Marpole period, utilitarian objects such as nephrite adze blades (or perhaps raw nephrite pieces) were exchanged down the Fraser River from the interior Plateau region (Fig. 5). These adze blades are found across a wide area, including the Gulf Islands, Vancouver Island, and areas of the coast to the north and south of the Fraser River delta. Dentalia shell from the west coast of Vancouver Island also reached the Lower Fraser River. Such shells are found in great numbers in graves at False Narrows in the Gulf Islands (Burley 1989) and at Lower Fraser River sites such as Scowlitz and Marpole (Lepofsky et al. 2000).

Regional Integration and Intensification after 2000 BP

From these data, it is clear that a wide range of objects and materials circulated within the Gulf of Georgia and some materials/items from outside the region were imported and redistributed throughout the region. Intra-regional exchange of commodities may have occurred in part as simple “down the line” exchange, particularly along rivers, and thus did not necessarily require long distance movements of people. Yet, certain lines of evidence indicate that such exchanges were embedded in increasing regional interactions, likely including the movement of people, as part of a process of increasing social and political integration and intensification and spatial expansion of economic interactions of the region after roughly 2000 BP.

One indication of this process is the large houses that first appear in the Gulf Islands and throughout the Gulf of Georgia after 2000 BP. These houses contained

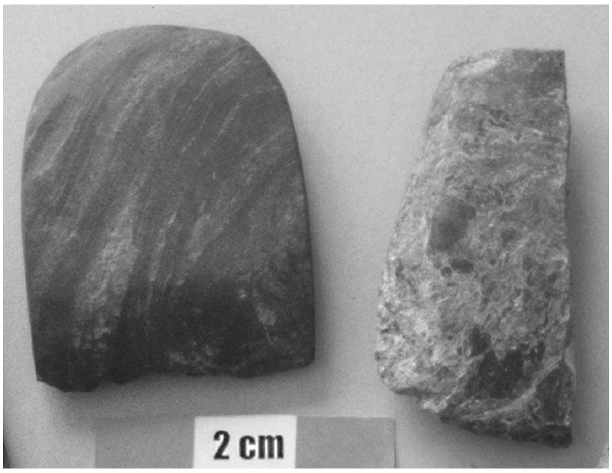

Fig. 5. Exotic nephrite adze blades typical of those found in Gulf of Georgia sites.

numerous families linked economically, socially, and politically in various respects as a corporate group (Coupland 1988; Grier 2001). The appearance of large, multifamily houses is an important marker of a substantial re-organization and intensification of the domestic mode of production, including marked increases in storage capacity and winter season sedentism (Ames 1996; Suttles 1991). The increased storage capacity offered by large houses suggests an increased reliance on stored resources, a major part of which was likely salmon. As the most storable and abundant resource in areas with major river systems, a major shift to a salmon storage economy is implicated as one (though not the only) driving factor in the development of large houses (Ames 1996; Croes and Hackenberger 1988; Matson 1992).

Extremely substantial and rich village sites, such as Scowlitz (Lepofsky et al. 2000), which includes numerous houses and many large burial mounds, and the Marpole site, which contained an incredible amount of stone sculpture (Duff 1956), flourished along the Lower Fraser River during the Marpole period (Fig. 2). While systematic regional study of Gulf of Georgia settlement patterns remains limited, the connection between large houses and villages, stored salmon resources, and the positioning of large sites in excellent fishing locales points to the Fraser River as having acted as a central economic and political focus of the interactive networks that developed in the region (Burley 1980; Grier 2003; Mitchell 1971).

More speculatively, the centrality of Lower Fraser sites from a regional perspective may not have resulted solely from their own positioning with respect to salmon stocks. They may have also flourished because they were in a position to control, limit or otherwise regulate access of other adjacent and more distant groups to Lower Fraser River fishing locations. I think this is a critical point in understanding the regional political dynamic that developed along the river after 2000 BP. Clark and Blake (1994) have discussed the importance of regional positioning of settlements in the centralization process critical to the development of early Chiefdoms. While the region clearly did not undergo a process of centralisation as that term is typically used to describe Chiefdoms, their point that we should expect prominent sites to develop at central nodes of resource availability and network connectivity is undoubtedly relevant to the situation. Scowlitz and Marpole define the east and west reaches of an incredibly productive segment of the Fraser River (Kew 1992) and an important conduit between ocean and interior environments and peoples.

From the perspective of Lower Fraser River groups, the goal of "controlling" resource access may not have been to exclude other groups from exploiting the Fraser River salmon stocks, but rather to facilitate access under conditions beneficial to themselves. Under conditions of abundance rather than limited resources, an exclusionary strategy may have served no economic, social, or strategic purpose, and competition for resources may have taken on a non-exclusionary form (see also Kim, this volume). Since labour was likely the limiting resource in terms of salmon harvesting (Kew 1992), collaborations with outside groups may have proven economically useful during the limited window of salmon spawning (often only a few weeks) in order to maximize productivity.

However, the advantages that may have accrued to Lower Fraser River groups by strategically exploiting their position within the region appear to have been limited. As mentioned, the prehistoric Northwest Coast lacked regionally-centralized polities and thus true Chiefdoms (though such centralization may have emerged in some regions during the historic period [see Martindale 2003]), and no archaeological argument for the existence of a fully prehistoric Chiefdom has been met with wide acceptance. Yet, clearly the core features of Marpole period organization developed initially and to their greatest degree in the Lower Fraser area. As a result, a direct equation of Marpole organization with intensive salmon exploitation has been advanced by a number of Northwest Coast archaeologists (Burley 1980; Mitchell 1971). Much work has yet to be done in order to model the particularities of the development of the Gulf of Georgia region. Evaluation of numerous existing models for this development (e.g., Burley 1980; Mitchell 1971) is not easily accomplished with extant archaeological data, as discussed below.

Empirical Approaches to the Study of a Regional System

From the perspective of reconstructing a prehistoric regional system of economic, social and political interactions, the archaeological record of the Gulf of Georgia region presents a variety of challenges. Certainly hard goods, both utilitarian and prestige, circulated through the region. In that they typically leave traces in the archaeological record, these goods have been useful in reconstructing regional trade dynamics, as discussed above (Carlson 1994; Grier 2003). However, for the study of two other important elements to the regional system – the exchange of perishable subsistence goods and the movement of people – more difficult problems ensue. Two primary issues exist in terms of their archaeological visibility: (1) they often lack direct material signatures and/or (2) they rarely can be traced to as a single discrete, identifiable source location. For example, during spawning runs on the southern British Columbia coast the same Pacific salmon stocks travel from pelagic areas of the Pacific Ocean through the Strait of Juan de Fuca and up The Fraser River system, ultimately reaching the central interior plateau. If we recover salmon bones from an archaeological site anywhere along this corridor, how do we infer where those salmon were caught? Were they caught and consumed locally or do they represent intra-regional trade in foodstuffs? Moreover, if far-flung groups are converging on the Fraser River for fishing at certain times of the year, how do we distinguish that avenue of salmon procurement from other possible scenarios (i.e., versus trade)?

Zooarchaeological Data

At first glance, zooarchaeological data appear to have significant potential to shed light on such problems. Examining the range of foodstuffs that were consumed in specific locales (as represented by their skeletal and shell remains) compared to where those resources occur within the region can provide a general indication of whether extra-local resources were acquired and consumed. But, as mentioned above, this does not tell us how they were acquired or how they were consumed. When attempting to measure food acquisition strategies and patterns of consumption at a finer grain, the use of zooarchaeological data from Northwest Coast sites is fraught with complex methodological problems. First, incredibly diverse food species ranging from sea urchin to whales must be quantified. This is not a straightforward task and often results in incomparability across taxa. Second, differing cultural practices with respect to the diverse species consumed pose significant problems. The complex food processing methods used to preserve food for storage can highly bias the zooarchaeological record, destroying specific elements or spatially separating animal part deposition (Butler and Chatters 1994). Third, natural preservation conditions are highly variable. Shell middens, containing elevated amounts of shell carbonates, can locally counteract the highly acidic PH of Northwest Coast soils, resulting in significant bone preservation. However, this does not occur universally, and not all sites contain abundant shellfish remains. This is particularly true of riverine sites, such as those of the Lower Fraser River, where shellfish with robust valves do not occur naturally. Thus, preservation of faunal remains is often poorest in riverine contexts where data are most critical.

Such factors can conspire to make traditional zooarchaeological approaches extremely challenging and often problematic. Nowhere has this been clearer than in attempts to identify the earliest intensification of salmon production and concomitant shift to a large scale storage-based economy (e.g., Cannon 1996, 2001; Croes and Hackenberger 1988; Matson 1992). An argument advanced by R. G. Matson has centred on the relative representation of head versus vertebral elements in faunal assemblages as a key measure of storage. His perspective is based on the premise that separation of head and body and discard of the head occurs during preparation of salmon for storage but does not typically occur in the consumption of fresh salmon. The vertebral elements move with the preserved salmon, and therefore vertebral elements should dominate in sites where stored salmon was consumed. Matson (1992) has argued that such a pattern is evident at the Crescent Beach site in the Fraser Delta. Salmon head part representation drops dramatically by roughly 3000 BP, indicating, at least to Matson, that the "development" of a salmon storage economy occurred on the Northwest Coast at this time.

While an interesting idea in principle, the argument is riddled with methodological and taphonomic problems. First, the complexity and variability of salmon processing techniques ethnographically precludes any such simple distinction between processing for fresh consumption and storage (Romanoff 1985). Second, head parts represent less dense and hardy parts of the salmon skeleton. As a result, density mediated attrition affects head parts to a much greater extent than vertebral elements, and overall significantly biases salmon assemblages toward vertebral representation (Butler and Chatters 1994). Third, in cases where a drop in head part representation through time is observed empirically, it is unclear whether this represents a change in the objectives of processing strategies (i.e., toward more storage-oriented) or simply a spatial reorganization of processing activities at that site (independent of whether salmon were processed for fresh consumption or storage) or perhaps a change in site function from a processing to consumption site (or vice versa). At the Crescent Beach site it is clear that head part representation does decrease over time, yet we have no idea (given the limited excavation area) if the head elements are in fact absent due to the preparation of the fish for storage, or whether those "missing" head parts are 10 m or 10 km away from their corresponding vertebral elements. It is simply not clear where the head parts went and that their absence is related to processing for storage on a large scale.

Stable Isotope Analysis

In light of such instances of equifinality, the difficulty in developing specific zooarchaeological signatures for behaviours identified as central to the development of intensive, storage-focused, regional economies is clear. Similar problems exist with respect to a variety of other zooarchaeological measures of complex behaviours. In particular, ascertaining the location of procurement of subsistence resources vis-à-vis their location of storage and ultimate consumption presents a challenging and persistent problem.

How might we productively approach the problem? The zooarchaeological signatures of behaviours of interest may be quite subtle, and in light of this we may be well served by shifting the focus from the zooarchaeological record to measuring the actual diets of individuals. Stable carbon and nitrogen isotope analyses are effectively suited to such a task. Recently, stable isotope values (carbon and nitrogen) for a suite of faunal species from the Dionisio Point site were generated by Michael Richards of the Max Planck Institute in Leipzig, Germany, The purpose of these analyses were to characterize the diet of the residents of the Dionisio Point village and, ultimately, to better identify regional patterns of resource acquisition and consumption (for a detailed discussion of stable carbon and nitrogen isotopic analysis methodology and interpretation, see Richards and Hedges [1999]).

For this purpose, stable nitrogen and carbon isotope values were obtained for archaeological elements of domestic dog (*Canis familaris*). The rationale behind analyzing dogs is that they should mimic human diet to a significant degree, assuming they were primarily "table scrap" feeders (Cannon et al. 1999). While not without some methodological assumptions, the approach is worth pursuing in an area where traditional zooarchaeological quantification of diet is difficult (as discussed above), and, moreover, where it is often politically unfeasible to conduct destructive analyses of human remains. A variety of common faunal taxa recovered from the site were also analyzed to provide an appropriate backdrop against which to measure the resulting dog values and variability therein.

Interestingly, the resulting carbon isotope values indicate that the diet of dogs was predominantly marine in origin, as d13 carbon values plot with marine-based organisms with values of roughly -16 o/oo and higher (Fig. 6). Since marine resources are not typically accessible to terrestrial dogs, this result points to an overall human-derived diet for dogs, and thus supports the "table scrap" feeder hypothesis. Stable nitrogen values suggest a prominent role for herring specifically in the diet of the Dionisio Point dogs, as the dog values are approximately 3 o/oo higher than herring values, which corresponds to the typical "trophic level" shift (Fig. 6). The importance of herring presents some interesting possibilities for interpretation. Herring "runs" occurred in early spring (typically March) when they spawned in large numbers and thus were concentrated in shallow bays for up to three weeks. Herring were extremely abundant in the Gulf Islands prior to Euro-Canadian commercial fishing. This fish is represented in substantial numbers (primarily by vertebrae) in Gulf Islands archaeological sites, and is ubiquitous in coastal archaeological sites generally. Massive numbers could be taken with the use of herring rakes by literally raking the herring from the surface of the water into basket or nets. Large quantities could have then been air dried or smoked for at least short-term storage.

While these fish may have been stored in abundance, it is very unlikely that herring, if preserved in spring, would last through the warm summer months due to spoilage. It is then difficult to argue that preserved herring could have lasted in quantity and quality beyond the summer, let alone provide a staple resource for large winter villages such as Dionisio Point. Nevertheless, the nitrogen isotope values for dogs suggest that herring was consumed beyond its limited fresh spring availability, since dogs obviously eat for more than just a few weeks in spring. The values therefore indicate that stored herring must have been a significant component of dog (and thus likely human) diet, and contributed protein beyond their fresh availability.

Shifting to consider the implications for human diet and also broader subsistence practices during the Marpole period, it interesting to note that a surplus of stored herring in the late spring and early summer would have been a useful trade commodity. The timing of availability of herring – both as a fresh resource in early spring and as a stored resource through at least early summer – corresponds to a low point in fresh resource availability in the otherwise "affluent" environment of the Gulf of Georgia (Monks 1987, Coupland 1991). Moreover, resources stored in the previous fall, such as salmon, would be nearing depletion or spoilage; resources that flourish in spring and ultimately mature later in the summer season would not yet be available in any quantity.

The abundance of herring in coastal waters could have provided an important "bridging" resource, and may have been traded with Fraser River groups and other riverine and inland groups awaiting the arrival of fresh summer resources. Herring may then have played a fairly significant role in the regional economy, not only as a basic foodstuff but also as a valued commodity that could be traded away by coastal groups in exchange for access to riverine and inland resources, notably salmon, later in the year. In this respect, it may also have been a commodity useful in the construction of social and political alliances.

While there are limitations to inferring human diet and diversity from dog diet, overall the stable isotope data provide some evidence that herring may have been processed for storage, suggesting that the exchange of herring deserves further consideration as an important

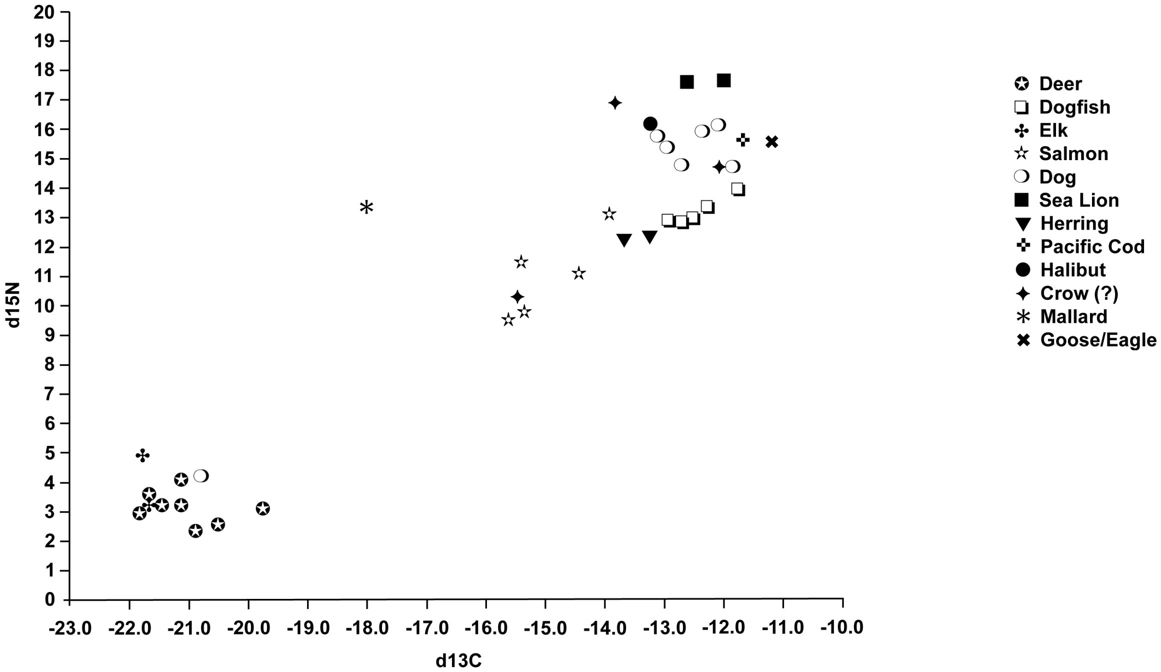

Fig. 6. Stable carbon and nitrogen isotope values for fauna from the Dionisio Point site

element in the interactions that occurred not only between Dionisio Point and Fraser River households but also as within the region more generally. There are potentially straightforward ways to evaluate this proposition with further isotopic analyses. For instance, do Fraser River peoples have isotopic signatures that suggest marine foods – specifically foods that may have been available at key times, such as herring – played a prominent role in their diet? If the answer turns out to be yes, this would in turn suggest, given the short window of herring availability, the widespread consumption of stored herring. Unless we posit that Fraser River peoples were spending spring months in the Gulf Islands (unlikely, see Coupland 1991), such a result would imply significant exchange of stored foodstuffs and a larger, more integrated regional economy than hitherto identified.

While much further work needs to be done, the generation of further isotopic data would help to piece together the regional exchange networks in foodstuffs throughout the region, as well as facilitate reconstruction of the regional economy and the long distance ties that allowed goods to flow through it. If these basic elements of the regional system can be established, we will have laid the groundwork for investigating the political dimensions of the regional economy as they developed after roughly 2000 B.P.

Conclusions: Beyond Unproblematic Affluence

What do these Northwest Coast-based observations tell us more generally about the investigation of prehistoric political economies and the role of "affluence" in their development? Clearly, it is important to model and empirically investigate various dimensions to the regional intensification process and the redistribution of resources and labour across regions. Yet, the critical point is to move further to consider the relationship of these processes to the social inequalities that developed along side them. In the Gulf of Georgia, burial data from the False Narrows site in the Gulf Islands (Burley 1989) and the Scowlitz site along the Lower Fraser (Lepofsky et al. 2000) indicate that by the mid-Marpole period, hereditary inequality was a factor in the sociopolitical context of the region. Inequality appears to have been an element of household organization as well. Analysis of artefact distributions within House 2 at the Dionisio Point site (Grier 2001) reveal the centralization and control of wealth and "sumptuary goods" in the hands of one household core group, suggesting that the social inequality expressed in mortuary contexts had a fundamental economic basis as well.

We must therefore view the posited exchanges of goods and labour as embedded in a developing system of social inequality. While it is critical to recognize that intensification may produce material surplus, it is social actors operating within that milieu that promote the uneven distribution of that surplus and engage in activities that promote inequality and restrict affluence to a select group, and who ultimately institutionalize those relations in social structures. In the absence of crisp conceptualizations of the role that social actors play in affecting resource flows in surplus economies, the regional economy of the Gulf of Georgia has been characterized as adaptive (e.g., Burley 1980; Suttles 1987). But while the Gulf of Georgia regional system may indeed have worked to redistribute resources, it apparently did little to promote social equality. Viewing the regional system as primarily adaptive offers only a limited and partial explanation for why Northwest Coast societies come to contain the most marked social inequalities of any known hunter-gatherer group.

In conclusion, and to offer a number of summary points that will hopefully move us beyond an unproblematic view of affluence on the Northwest Coast (and elsewhere), I argue that we must:

1. refocus on affluence not as a homogenous property of a society, but as a dynamic that fuelled the construction of economic, social, and political inequalities in prehistory;
2. consider multiple scales of analysis, as it is these various scales at which production, consumption, and exchange occurred;
3. conceptualise actors with interests, be they groups or individuals, as catalysts in the intensification of production and promotion of inequality;
4. view economics as more than simply material processes, in order to bring the economics of surplus production out of the realm of a restricted view of intensification and affluence as adaptive or stemming solely from ecological imperatives.

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Colin Grier
Department of Anthropology and Sociology
University of British Columbia
6303 NW Marine Drive
Vancouver
BC Canada V6T 1Z1
Email: grier@telus.net

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 136–167

11. The Environmental Troublemaker's Burden?: Jomon Perspectives on Foraging Land Use Change

Junzo Uchiyama

Over the past 25 years the "Affluent Forager" and "logistic mobility" models have been useful for characterizing synchronic patterns of land use of prehistoric complex foragers. However, these models have failed to explain processes of change in the mobility patterns of foragers from the temperate zones. In light of the "Affluent Forager" model, it has been suggested that foraging groups in Japan during the Jomon period (12,000–2500 BP) employed year-round sedentism and collected necessary foodstuffs from within a 10 km radius from settlements. Moreover, it was assumed that this was a stable and long-term system, unless changes in the natural environment induced spontaneous cultural responses. However, recent studies have revealed fluctuations in the mobility pattern involving alternating between clumped *(large core settlements) and* dispersed *(dispersed small sites) systems. In this paper, the factors producing these land use changes are discussed through an interpretation of the Torihama site (Initial-Final Jomon, 11,000–2500 BP). Analysis of the faunal assemblage from the Torihama site reveals a highly organized system of land use that reflects intensive resource use during the Early Jomon shellmidden period. However, population increases at residential bases eventually led to deforestation of the surrounding area, resulting in the frequent occurrence of floods and debris-avalanches, making the site area less attractive for intensive resource exploitations. This phenomenon may have led fostered a change from clumped land use to a dispersed pattern, and suggests that human impact on the local environment played an important role in settlement pattern changes in prehistoric complex foragers.*

The "Affluent Forager" Model

In this paper I consider the factors that produce changes in land use patterns among foraging groups based on results of an analysis of the faunal assemblage from the Torihama site (Initial-Final Jomon, 11,000–2500 BP) on the southern Japan Sea coastline (Fig. 1). The "Affluent Forager" and "logistic mobility" models have been useful for characterizing the static land use of prehistoric complex foragers in temperate coastal zones, however, these models have failed to explain the broader process of economic change – how and why those foragers shifted their mobility patterns. In this paper, I first present background on the "Affluent Forager" model and, second, discuss its problems through an interpretation of the Torihama data.

In the more than 20 years since its first appearance at the end of the 1970s, "Affluent Foragers" has been a term used to describe the particular socioeconomic conditions of coastal fisher-hunters such as prehistoric Jomon societies (c. 12,000–2500 BP) and Northwest Coast indigenous groups (Koyama and Thomas 1982) of the northern Pacific Rim. This term was derived from the phrase "Original Affluent Society", as coined by Marshall Sahlins in *Man the Hunter* (Sahlins 1968, 85) to describe the lifeways of nomadic hunter-gatherers. Sahlins proposed that an egalitarian socio-economic base, high mobility, no food storage, and no strong claims on territoriality characterize band-size hunter-gatherer groups. Sahlins considered that hunter-gatherers approach affluence according to the Zen concept of "want

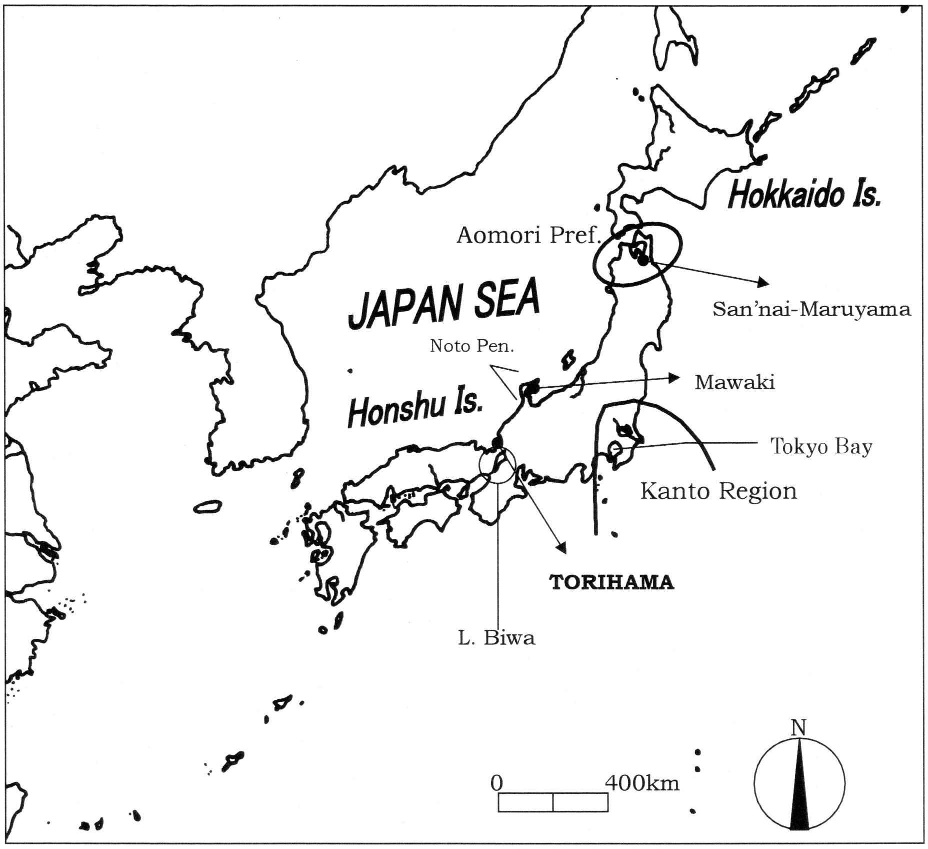

Fig. 1. Map of the Japanese archipelago and regions and sites discussed in the text.

not, lack not" (Sahlins 1972, 11). This is quite different from the "Galbraithian course" that is "peculiarly appropriate to (modern) market economies" in which wants are great and provisioned through increased productivity (Sahlins 1968, 85, see also Rowley-Conwy 2001).

In contrast to Sahlins, Koyama and Thomas considered the affluence of foragers in coastal areas from the "Galbraithian" perspective. Their assumptions were:

1) Coastal fisher-hunters of temperate zones enjoyed "environments of abundance" (Aikens 1982, 262), i.e., various kinds and massive amounts of natural resources.
2) To the extent that they pursued available resources consistent with Optimal Foraging Theory (Smith 1983), coastal foraging groups during the Holocene developed highly organised social structures and high-levels of sedentism (e.g., Schalk 1982).
3) In the case of Jomon Japan, the abundance of resources and finely tuned adaptations to the environment made social groups strongly "resist the impact of agriculture and … evolution toward agricultural society" (Sasaki 1982, 15). Thus the Jomon foraging society lasted approximately for 10,000 years from the end of the last glacial age; the Northwest Coast societies maintained a hunting and gathering system into the 20th century.

Despite the perspective on "affluence" taken, there is general agreement that Jomon society satisfies the criteria and conditions of complex foragers in archaeological contexts. Large-scale sites accompanied by a number of residential and storage pits, the existence of pottery and the utilization of wide-ranging aquatic/terrestrial resources suggest that Jomon social groups were very highly organized and depended upon seasonally migratory species. Based on an analysis of faunal remains and site location patterns, Akazawa (1983, 1986) attempted to reconstruct the structure of the Jomon subsistence system by using site catchment analysis (Vita-Finzi and Higgs 1970). It was assumed that the daily range for the subsistence activities of Jomon foragers was defined by a circle around a site with a radius equal to two hours walk (approximately 10 km), and that most species retrieved from Jomon sites were available within this field.

Furthermore, large Jomon settlements tend to be located at junctions of different environments such as forest-estuary and forest-freshwater ecosystems. Occupying such ecotones must have made food procurement more efficient. On this basis, Akazawa inferred that Jomon groups did not need to search for foodstuffs outside their site catchment area throughout the year. Thus, self-sufficiency within a 10 km radius and year-round sedentism were core Jomon economic principles. In other words, Akazawa's model portrays Jomon subsistence as a combination of many contiguous local subsistence catchments. I call this model "Model-Zero" since it does not make provision for Jomon settlement shifts and considers every large settlement as an independent year-round residential base.

Problems with Model-Zero

"Model-Zero" (MZ) can be said to be an embodiment of the "Affluent Forager" scheme from the perspective of land use. The articulation of MZ was an important step in providing a spatial characterization of the Jomon lifestyle. Even so, several problems have been overlooked in developing this model. The first problem lies in the assumption that the daily range of subsistence acquisition was within 10 km of residential bases. The value of 10 km was based on the daily foraging radius of the South African !Kung (Akazawa 1983), whose environment is and was quite different from Jomon-period Japan. The !Kung live in flat, dry and open land. In contrast, the Japanese Islands are full of dense forests, rugged terrain and rapid streams. Consequently, Jomon groups may have been more spatially restricted than their !Kung counterparts. Furthermore, due to frequent settlement moves (5 to 10 times a year), the actual area of !Kung exploitation is much larger than 10 km (Kelly 1995, Fig. 4-4). Considering these facts together, there seems no *a priori* reason to posit Jomon year-round sedentism.

More importantly, all subsistence activities were not necessarily carried out within only a small daily foraging radius. Judging from faunal assemblages, three kinds of food resources were utilized in the Jomon period: (1) seasonally migratory species including fish and birds; (2) species with very local habitats such as shellfish and small mammals; and (3) medium or large size mammals with wide ranges such as deer and wild boar. Among these, the hunting of the larger size mammals requires a the widest area of pursuit. Various ethnographic records of traditional hunting villages in modern Japan also establish this point. For example, bear hunters in northern Honshu set up a hunting camp in the mountains approximately 10 to 15 km away from their village (see also Ikeya, this volume). A specialist team engaged in winter hunting, using the camp as an operational base. Chase hunting, combining dogs and guns, was the main method used. Hunting excursions took several days to carry out and covered ground more than 10 km away from the camp (Taguchi 1999, 110–3). These data suggest that teamwork activities, which are typically performed by specialists such as those who specifically hunt large mammals, tend to be carried out beyond the daily foraging radius.

Finally, the most serious problem is the neglect of the fact that any one subsistence parcel (catchment zone) is not a closed system. This problem is not only an aspect of the MZ but also of other discussions of logistic mobility models (e.g., Binford 1980, see also Kim, this volume). Subsistence parcels are actually quite an open system in two senses. First, it is open to other social groups, regardless of distance. Various forms of trading networks, socio-political relationships and territorial sharing between neighbours influence local subsistence systems. Second, subsistence systems are closely connected with the local environment. It is clear that natural conditions are crucial in affecting the form of subsistence, however, it should be noted that human activities also influence the natural surroundings even under foraging conditions in prehistory. Forest fires controlled by Australian Aborigines and the extinction of freshwater species in prehistoric Japan (Nakajima, this volume) provide examples of this. If each subsistence parcel had been socially isolated and resistant to impact and degradation from human groups, there would be little reason to expect that any group would change its socio-economic lifestyle and land-use pattern. However, such changes frequently occurred throughout the Jomon era, as discussed in the next section.

All of these points suggest three characteristics of Jomon subsistence (Fig. 2):

1. Jomon society was surely endowed with the socio-economic characteristics of typical complex hunter-gatherers; however this does not mean that Jomon settlement patterns consisted only of a year-round sedentary base camp.
2. Jomon subsistence strategy was not restricted to a highly defined daily foraging radius, that is, in the terms used by Binford (1980) Jomon hunter-gatherers were not so much foragers as collectors. In particular, some activities that required task-specialists, such as large mammal hunting, were probably carried out far beyond the 10 km daily radius. Jomon settlement patterns also consisted of several components such as year-round/seasonal bases and hunting camps.
3. Any one Jomon subsistence parcel was quite an open system with respect to (a) other parcels and (b) environmental change. As for the latter, it should not be overlooked that even foraging or prehistoric societies develop control over their surroundings to a considerable extent. It is probable that these two 'open doors' are prime movers of change in subsistence systems and thus settlement patterns.

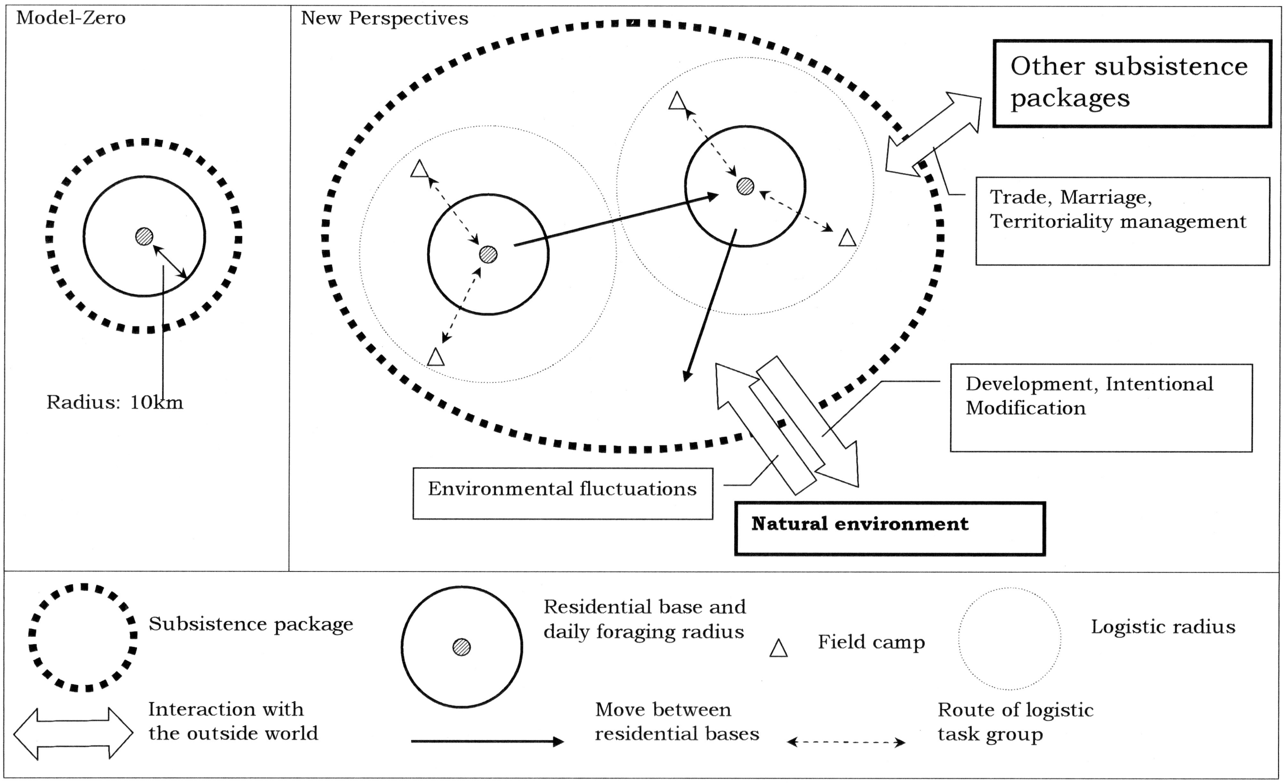
Model-Zero
Radius: 10km
New Perspectives
Other subsistence packages
Trade, Marriage, Territoriality management
Development, Intentional Modification
Environmental fluctuations
Natural environment
Subsistence package
Residential base and daily foraging radius
Field camp
Logistic radius
Interaction with the outside world
Move between residential bases
Route of logistic task group

Fig. 2. Schematic contrasting Model-Zero (left) with New Perspectives (right).

Jomon Fluctuations

Looking at settlement distributions with respect to the chronology of the Jomon period, many different patterns may be observed, though broadly speaking two main types of settlement pattern are evident: clumped and dispersed. The clumped pattern can be defined as the combination of a few large sedentary sites and many small sites (Fig. 3). This pattern can be seen, for example, on the Japan Sea coast of southern Honshu in the Early Jomon (6000–5000 BP) and in northern Honshu in the Middle Jomon (5000–4000 BP). Large-scale, lowland, freshwater shell-midden sites on lagoons or lakes characterize the Early Jomon along the southern Japan Sea coastlines, whereas far smaller sites have been recognized mainly in mountainous areas. On the other hand, in northern Honshu during the Middle Jomon, large-scale settlements were formed on flatlands. For example, the San'nai-Maruyama site, one of the largest residential sites of the Jomon era, consists of more than 500 residential pits, 1000 storage pits, and 2000 graves, accompanied by a wooden tower estimated to have been more than 20 m in height (Okada 1995, see Fig. 1 for site location). Judging from the scale difference between large sedentary and small sites, the population level of the large sites must have been very high and these sites played a major role as local socioeconomic centres. Wide-ranging trade networks circulating jade beads or serpentinite adzes were more prevalent under the clumped pattern.

Meanwhile, in the dispersed pattern, which was more characteristic of Middle and Late Jomon, site size differences became almost non-existent. The average size of sites was comparatively very small and sites were distributed sparsely (Fig. 3). The Middle Jomon of southern Honshu and the Late Jomon of northern Honshu are examples of this pattern. In this pattern, large-scale religious sites, such as stone circles and cemeteries, were constructed. It is noteworthy that in the shift from clumped to dispersed the total number of sites did not always decrease. For instance, in northern Honshu the number of sites increased considerably in the Late Jomon, although San'nai-Maruyama was abandoned in the early stage of this phase (Fig. 4). The sequence from a clumped to dispersed settlement pattern may not necessarily imply a decrease in population, but rather that the land use and resource development system changed from a centralized and intensive one to a more dispersed and extensive system. It should also be noted that large-scale religious/ritual sites tended to be more prevalent in dispersed pattern stages. In northern Honshu and southern Hokkaido, many stone circles, often with a radius of more than 20 metres, characterize the Late Jomon phase. These circles were normally accompanied by burial areas and

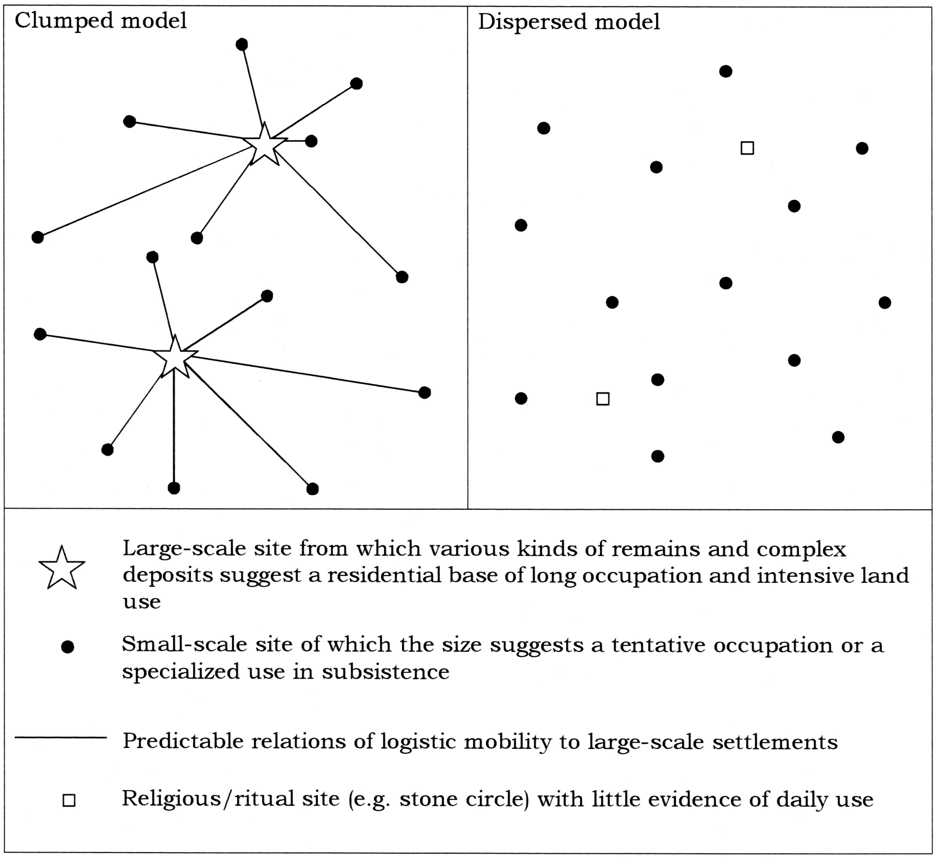
Clumped model
Dispersed model
☆ Large-scale site from which various kinds of remains and complex deposits suggest a residential base of long occupation and intensive land use
● Small-scale site of which the size suggests a tentative occupation or a specialized use in subsistence
——— Predictable relations of logistic mobility to large-scale settlements
□ Religious/ritual site (e.g. stone circle) with little evidence of daily use

Fig. 3. Schematic depicting a clumped (left) and dispersed (right) model of settlement pattern.

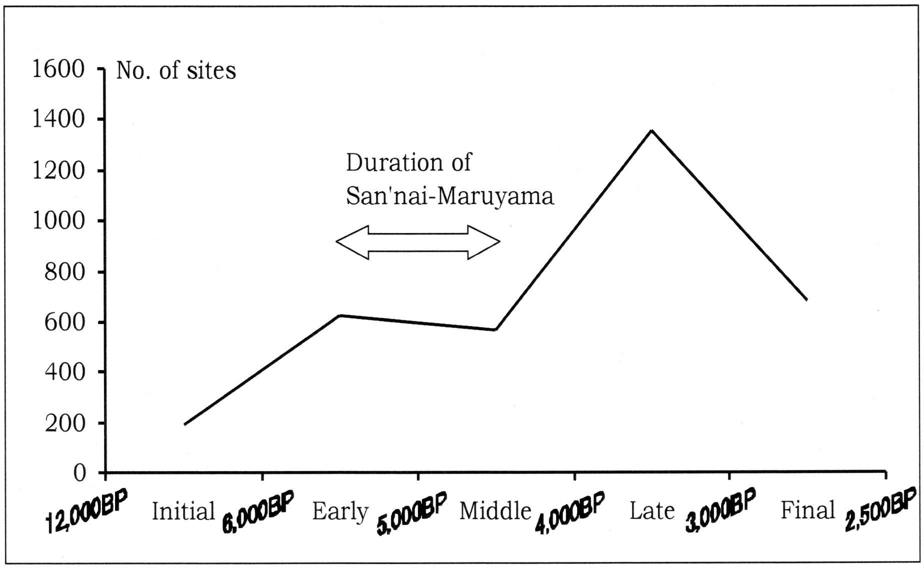

Fig. 4. The number of Jomon Sites in Aomori Prefecture (9606 sq. km). The data is listed in Koyama and Oikawa (1996), Table 1.

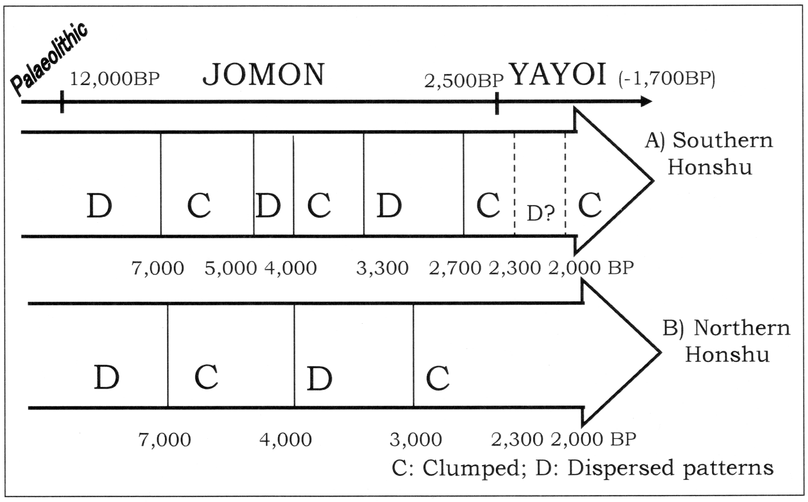
Palaeolithic
12,000BP
JOMON
2,500BP
YAYOI
(-1,700BP)
A) Southern Honshu
D
C
D
C
D
C
D?
C
7,000 5,000 4,000 3,300 2,700 2,300 2,000 BP
B) Northern Honshu
D
C
D
C
7,000 4,000 3,000 2,300 2,000 BP
C: Clumped; D: Dispersed patterns

Fig. 5. Approximate outline of settlement pattern transitions in southern and northern Honshu, based on information on shifts in numbers of sites and archaeological features as provided (for A) by Seguchi (2001a, 2001b, personal communication) and Koyama and Oikawa (1996) and Sudo and Imaizumi (1992) for B.

various ritual paraphernalia, including clay figurines, but rarely by residential pits.

The affluent forager model depicts the land use pattern of temperate foraging groups as highly clumped and sedentary. However, as described above, Jomon groups did not always employ only clumped settlement patterns. Actually, Jomon land use can be described as a cycle of alternating clumped and dispersed patterns. Based on the examples from northern Honshu and the southern Japan Sea coast (Fig. 5), the patterns alternate on at least three or four occasions between dispersed and clumped. If the overall shift in settlement is to be explained in terms of socioeconomic evolution, why did the clumped settlement pattern ultimately change into a dispersed type? Because (1) such a change is often apt to look like social degeneration and (2) there is no evidence of social conflict caused by an influx of new groups from the continent in the Jomon era, the change is frequently explained by invoking environmental disruptions as a cause. While local ecological shifts stemming from broader (even global) changes in the environment cannot be ignored, is it possible that the changes in settlement patterns were caused, in part at least, by disruptions engendered by humans groups themselves?

In order to investigate this possibility, below I consider the Torihama site, which stands as an important example of a site that existed across a chronological shift from a clumped to dispersed pattern. To begin with, I reconstruct land use structure during the clumped pattern period based on zooarchaeological analysis, and the seasonal schedule and site function of Torihama itself is examined. The causes of settlement pattern shift are then discussed by considering additional environmental factors.

The Torihama Site: Overview

The Torihama site is located in the middle of Honshu on the southern Japan Sea coast. Though occupation at the site started in the early Initial Jomon (11,000 BP), a large-scale shellmidden formed in the Early Jomon (6000 BP), which is the period during which a clumped settlement pattern was employed (for convenience, I refer to the Torihama site during the clumped pattern period as the "Torihama shellmidden"). However, at the end of the Early Jomon phase (5500-5000 BP), the size of the site was drastically reduced and the shift to a dispersed pattern occurred. The site was still in use until the Final Jomon (3000-2500 BP), but was occupied only intermittently. It appears that Torihama was located in lowlands facing directly on to a lagoon that was strongly influenced by freshwater (Fig. 6). The zooarchaeological assemblage analysed here is that excavated in 1984 from a stratum with a specific pottery type belonging to the middle of the Early Jomon (Fukui Prefectural Board of Education and Fukui Prefectural Museum of History 1985). The total amount of bone is approximately 185 kg in desiccated condition. In spite of the limited use of water sieving for recovery of the 1984 assemblage, research from the 1960s through 1980s has established that the main terrestrial game hunted was sika deer (*Cervus nippon*) and wild boar (*Sus scrofa*), whereas freshwater species of mussels (Family *Uniodae*), clams (Family *Corbiculidae*) and crucian carp (*Carassius* sp.) are dominant among aquatic resources. Small-scale cultivation could also have been carried out based on recovery of botanic remains such as bottle gourd (*Lagenaria siceraria*), perilla (*Perilla frutescens*), and also perhaps soybean (*Glycine max*) (Kasahara 1984; Nishida 1980).

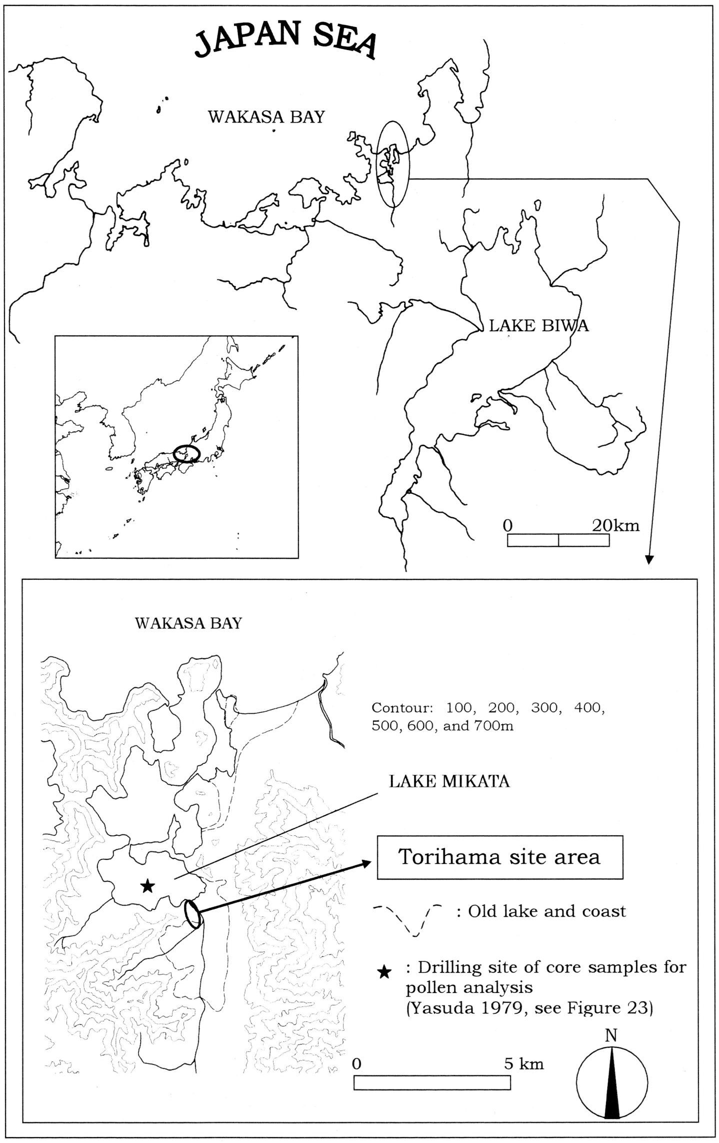
JAPAN SEA
WAKASA BAY
LAKE BIWA
0 20km
WAKASA BAY
Contour: 100, 200, 300, 400, 500, 600, and 700m
LAKE MIKATA
Torihama site area
: Old lake and coast
★ : Drilling site of core samples for pollen analysis (Yasuda 1979, see Figure 23)
N
0 5 km

Fig. 6. Location of the Torihama site.

Torihama Analysis 1: Seasonal Schedule

Seasonality of the site was established in three ways. Firstly, it was estimated from the distribution of measurements of the jaws of deer, which is the dominant terrestrial species and gives birth in a specific season (the end of May to early June). If the distribution pattern of mandible sizes shows a specific age profile that differs from that expected in the case of year round hunting, then such a result strongly suggests that deer hunting was carried out only in a specific season. When combined with age estimations of each jaw based on tooth eruption and wear, the hunting season of the deer can accurately be determined. The second method was the observation of tooth eruption stages of wild boar. Most wild boar jaws were damaged and thus it was difficult to obtain measurements. However, wild boar is the second dominant mammal and the number of jaws recovered was high, providing sufficient measurement data overall. Furthermore, wild boar also give birth in a specific season, at almost the same time of year as sika deer. Thus observing tooth eruption stages will provide fairly good indications as to the hunting season. The third and final approach was to focus on the remains of seasonal migratory species such as fish and birds. If remains of such species are retrieved from the site, their presence suggests seasons when the site was actually occupied and in use.

The points measured on the deer jaws were the height of the mandible anterior to the P2 and the length of the mandibular premolar row (Fig. 7). The mandible height increases with body growth, whereas the length remains

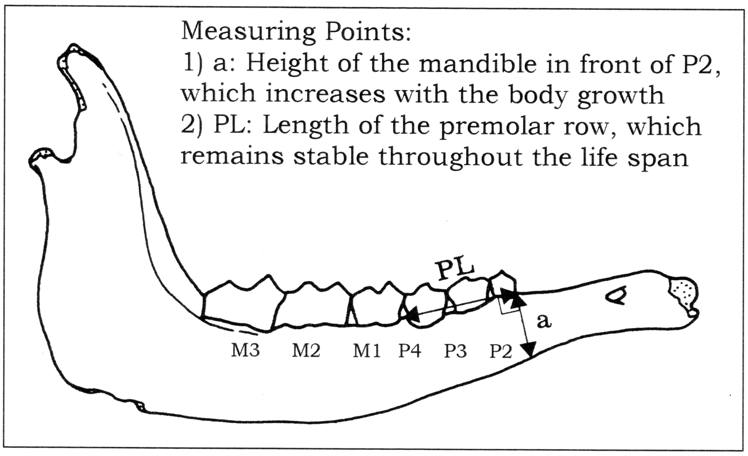
Measuring Points:
1) a: Height of the mandible in front of P2, which increases with the body growth
2) PL: Length of the premolar row, which remains stable throughout the life span
PL
a
M3
M2
M1
P4
P3
P2

Fig. 7. Measuring points on deer mandibles for determination of season of death.

stable throughout life. Consequently, the distribution graph of the proportion of these values will express the age structure of the assemblage (Uchiyama 1999). The results are shown in Fig. 8 and Fig. 9. In Fig. 8, age assessment was carried out by age class as proposed by Lowe (1967). Also, I use Brown and Chapman's data for red deer (Brown and Chapman 1991a, 1991b) to estimate the season of Torihama deer death, because there is no major difference in tooth eruption stages between European red deer (*Cervus elaphus*) and sika deer in the early stage of life (Uchiyama 1999, 2002a, 2002b). As shown in Fig. 9, the distribution pattern is clearly divided between young calves and adults. Considering the death season of young calves, the gap between the juveniles and adults is caused by summer-autumn seasonal hunting (Fig. 10).

In the assessment of wild boar teeth (Fig. 11), Higham's observations of tooth eruption stages (Higham 1967, Appendix B) and Grant's Tooth/Mandible Wear Stage (Grant 1982) were used. My recent research on modern hunted boar in central Honshu suggests that at least the tooth eruption stages are consistent with Higham's results (Uchiyama 2002a). As a result, the seasonality assessment using wild boar jaws contrasts with that of deer. That is, the hunting of wild boar was much more of a year-round activity, but it tended to intensify in winter to early spring (Fig. 12). The age structures of each species (Fig. 13 and 14) tend toward young adults, indicating chase hunting carried out by small groups.

There are four kinds of additional resources for which seasonality can be estimated: freshwater and marine fish, nuts, and cultivated plants (Hongo 1989; Kasahara 1984; Nishida 1980; Uchiyama 2002a, 2002b). To begin with, freshwater fish were mainly crucian carp (*Carassius* sp.) (Hongo 1989). I have noted elsewhere that carp family fish such as crucian carp were a critical protein source for Jomon groups along the southern Japan Sea coast because the catch was predictable and large during its spawning season (mainly early summer) and many freshwater lakes and lagoons existed in that area at the time (Uchiyama 2001, 2002a). The fishing season for marine fish must have been concentrated in summer, the general spawning season, since it is comparatively more difficult to catch these fish in other seasons. Furthermore, nuts such as acorns, walnuts and chestnuts, which mature from September in this part of Japan, must have been collected in the early autumn. Finally, if the bottle gourd, the major cultivated species, was in fact being cultivated at the site, it was likely seeded in May and harvested in October. Therefore, putting these results together with those from deer and wild boar, the seasonality of Torihama shellmidden is summarized in Fig. 15. Except for wild boar hunting, all activities were carried out during a limited period of the year – summer to autumn.

Torihama Analysis 2: Site Function

Among the Torihama assemblage excavated in 1984, deer and wild boar mandibles number 119 and 100 in MNE respectively, all of which were used for the seasonality assessment (Fig. 8 and 11). A high concentration of accumulated bone was recognized from only one layer (layer No. 37) belonging to the middle of the Early Jomon. This concentration covered a comparatively small area (45 sq. metres named section T2, see Fig. 16 for the location). The total dry weight of these bones is 36 kg and the total NISP was 887 (Fig. 17). MNI comparison across species (Fig. 18) indicates that deer and wild boar were the main terrestrial species consumed at Torihama, which is the general tendency for Jomon sites overall. The condition of preservation of the assemblage in this section is relatively good. Since the layer had been saturated with ground water, various soft and fragile bones such as mammal scapulae and fish bones were

*: a or PL is estimated		Tooth Attrition Stage										Measurements (mm) a&PL: see Figure 4			Measurements in mm		Brown and Chapman (1991a, b)	Lowe (1967)
No.	layer	R/L	dp2	dp3	dp4	P2	P3	P4	M1	M2	M3	a	PL	a/PL*100	M1 length	M1 width (on first cusp)	Age (months) based on eruption	Age Class
80112	9	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80113	12	L	–	–	–	W	W	W	W/W	W/J	J/J/J	21.50	38.20	56.28	17.10	11.30	–	4
*80114	38	L	–	–	–	Bk	Bk	S/O	–	–	–	20.50	–	–	–	–	–	–
80115	12	R	–	–	–	W	HW	HW	HW/HW	FW/FW	FW/FW/FW	22.60	35.80	63.13	13.50	10.50	–	7
80116	25	L	–	–	–	–	–	–	S/O	W/W	W/W/FW	–	–	–	–	–	–	5
80117	25	R	–	–	–	W	W	W	–	–	–	20.70	36.60	56.56	–	–	–	–
80118	12	L	–	–	–	–	–	–	S/O	Bk	W/W/W	–	–	–	–	–	–	5
80119	12	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80120	12	L	–	–	–	J	W	W	FW/FW	W/J	J/J/U	18.40	34.80	52.87	15.20	10.30	–	3
*80121	A	L	–	–	–	SO	J	W	W/W	W/J	J/J/H	21.00	38.70	54.26	15.90	10.60	–	2
80122	B	L	–	–	–	J	W	W	W/W	W/W	W/J/J	21.50	35.70	60.22	15.90	10.80	–	4
80123	–	L	–	–	–	W	W	W	FW/HW	W/W	W/J/J	25.70	38.40	66.93	15.90	11.40	–	5
80124	24	L	–	–	–	W	W	W	FW/FW	FW/FW	W/W/FW	24.00	37.20	64.52	15.10	10.80	–	5
80125	40	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80126	24	L	–	–	–	W	W	FW	FW/FW	FW/W	W/J/J	23.50	35.80	65.64	15.50	11.10	–	5
80127	A	R	–	–	–	SO	W	W	W/W	W/J	J/J/H	20.90	38.40	54.43	16.30	10.60	–	2
80128	45	R	–	–	–	W	W	W	FW/FW	FW/W	W/J/FW	21.20	36.40	58.24	15.30	10.30	–	5
80129	B	L	–	–	–	W	W	W	FW/FW	W/J	W/J/J	22.90	37.10	61.73	14.50	10.10	–	4
80130	A	L	–	–	–	J	W	W	W/W	W/J	J/J/U	20.60	36.80	55.98	15.90	10.20	–	3
*80131	A	L	–	–	–	W	W	W	HW/HW	FW/W	W/J/FW	24.00	35.70	67.23	15.40	11.00	–	5
80132	A	L	–	–	–	W	FW	HW	HW/HW	FW/FW	FW/W/FW	22.10	35.40	62.43	15.30	11.60	–	6
*80133	–	R	SO	W	FW/FW/FW	–	–	–	J/J	J/J	S/O	–	44.40	–	18.00	–	14–18	1
80134	24	R	W	W	FW/HW/W	–	–	–	W/J	J/J	V/–/–	20.00	40.20	49.75	18.10	–	15–17	1
80135	24	L	–	–	–	J	W	W	FW/FW	W/J	J/J/J	19.70	35.50	55.49	15.00	10.90	–	4
80136	24	R	–	–	–	J	W	W	FW/FW	W/W	W/J/J	19.80	34.30	57.73	15.10	11.10	–	4
80137	38	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80138	–	R	–	–	–	J	W	W	FW/W	W/W	W/J/J	20.60	33.80	60.95	15.10	10.10	–	4
*80139	B(?)	R	–	–	–	S/O	W	W	W/W	W/W	W/J/J	–	–	–	15.40	10.60	–	4
*80140	B	R	–	–	–	W	W	W	FW/FW	FW/W	FW/FW/FW	21.40	33.60	63.69	14.70	10.60	–	6
80141	25	R	–	–	–	FL	FL	FL	FL/FL	HW/HW	HW/HW/FL	24.40	36.10	67.59	12.80	10.80	–	9
80143	24	R	J	W	HW/HW/FW	–	–	–	W/J	J/J	C/–/–	18.80	39.70	47.36	17.40	10.00	15	1
80144	–	R	–	W	–	C	–	C	W/J	J/J	S/O	17.70	41.80	42.34	17.40	–	15–17	1
80145	A	R	–	–	–	W	W	W	FW/J	W/J	J/J/H	21.90	38.30	57.18	17.00	10.70	–	3
80146	A	L	–	–	–	W	W	W	FW/W	W/W	W/J/J	22.40	35.00	64.00	15.30	10.90	–	4
80147	–	L	–	–	–	HW	FW	FW	HW/HW	W/FW	W/FW/FW	21.30	33.60	63.39	15.00	10.80	–	7
80148	–	R	–	–	–	–	W	FW	FW/HW	W/W	W/J/J	21.20	38.30	55.35	14.40	10.50	–	4

Fig. 8. Sika deer mandible data from Torihama shellmidden.

*: a or PL is estimated		Tooth Attrition Stage										Measurements (mm) a&PL: see Figure 4			Measurements in mm			
No.	layer	R/L	dp2	dp3	dp4	P2	P3	P4	M1	M2	M3	a	PL	a/PL*100	M1 length	M1 width (on first cusp)	Brown and Chapman (1991a, b) Age (months) based on eruption	Lowe (1967) Age Class
80356	37	R	–	–	–	Bk	Bk	Bk	–	–	–	–	–	–	–	–	–	–
80357	C	R	–	–	–	–	S/O	W	W/J	J/J	J/J/U	–	–	–	17.10	11.10	–	3/4
80358	12	R	–	–	–	–	–	–	S/O	W/W	W/W/Bk	–	–	–	–	–	–	4
80359	52	R	–	–	–	HW	FW	FW	HW/HW	FW/W	FW/W/FW	21.80	34.50	63.19	15.10	11.30	–	7
80360	37	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80361	37	R	–	–	–	–	–	–	S/O	Bk	Bk	–	–	–	–	–	–	–
80362	37	L	–	–	–	–	–	–	–	–	S/O	–	–	–	–	–	–	–
80363	52	R	–	–	–	W	W	W	W/W	W/J	W/J/J	23.50	38.40	61.20	15.70	11.10	–	4
80364	30	L	–	–	–	W	W	HW	FL/FL	FW/HW	FW/FW/FW	21.00	35.90	58.50	13.80	10.10	–	9
80365	52	L	–	–	–	J	W	W	W/W	W/J	J/J/U	21.70	33.90	64.01	15.40	10.50	–	4
80366	37	R	–	–	–	W	W	W	FW/HW	W/W	W/J/FW	22.80	36.00	63.33	16.20	11.80	–	5
80367	40	L	–	–	–	W	W	W	FW/W	W/J	W/J/J	23.40	36.90	63.41	16.40	11.40	–	3
80368	12	L	–	–	–	W	W	W	FW/W	W/J	J/J/U	21.50	36.80	58.42	16.10	10.90	–	3
*80369	30	R	–	–	–	Bk	W	W	HW/HW	Bk/Bk	FW/FW/FW	24.40	33.80	72.19	15.30	10.30	–	5/6
80370	52	R	–	–	–	J	W	W	W/W	W/J	J/J/H	19.50	34.30	56.85	15.50	10.30	–	3
80371	37	L	–	–	–	HW	Bk	Bk	S/O	–	–	20.20	36.00	56.11	–	–	–	–
80372	37	L	–	–	–	W	Bk	Bk	Bk	Bk	Bk	25.80	37.20	69.35	–	–	–	2<
80373	60	L	–	–	–	HW	HW	HW	FL/HW	FW/FW	FW/FW/FW	20.90	32.10	65.11	13.20	12.40	–	8
80374	49	L	–	–	–	W	W	FW	HW/HW	FW/FW	FW/W/FW	24.40	35.70	68.35	14.00	12.40	–	6
80375	25	L	–	–	–	–	–	–	S/O	W/J	W/J	–	–	–	16.80	10.70	–	2/3
80376	37	R	–	–	–	–	–	S/O	Bk	J/J	E/V/–	–	–	–	–	–	16–18	1/2
80377	52	L	–	–	–	W	W	W	FW/W	W/J	J/J/U	20.80	37.60	55.32	15.40	11.10	–	3
80378	52	R	–	–	–	J	J	W	W/W	W/J	J/J/J	21.40	34.10	62.76	15.30	10.50	–	4
80379	52	R	–	–	–	SO	W	FW	FW/W	FW/W	W/W/W	22.70	34.40	65.99	14.40	11.30	–	6
*80380	37	R	–	–	–	SO	Bk	Bk	Bk	Bk	Bk	22.50	35.30	63.74	–	–	–	–
80381	35	R	–	–	–	W	W	W	HW/HW	FW/W	W/W/FW	24.80	35.80	69.27	16.00	11.20	–	5
*80382	40	L	–	–	–	HW	FW	HW	FL/HW	FW/FW	FW/FW/FL	24.40	34.40	70.93	13.90	10.50	–	9
80383	40	L	–	–	–	Bk	W	HW	FL/HW	HW/HW	HW/HW/FL	24.20	34.20	70.76	13.40	10.50	–	9
80383	26	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80384	30	L	–	–	–	J	J	J	W/J	J/J	J/J/U	20.10	37.90	53.03	15.70	11.00	–	3
80385	26	L	–	–	–	Bk	W	W	FW/W	W/J	W/J/W	24.30	38.90	62.47	16.00	10.90	–	4
80386	52	R	–	–	–	W	W	W	FW/FW	W/W	W/J/J	21.50	36.20	59.39	15.90	11.10	–	4
80387	12	R	–	–	–	HW	HW	FW	FW/HW	FW/FW	FW/W/FW	22.00	36.60	60.11	16.10	11.30	–	6
80388	37	R	–	–	–	Bk	S/O	–	–	–	–	22.70	–	–	–	–	–	–
80389	31	L	–	–	–	SO	W	W	FW/HW	Bk	W/J/W	23.10	32.30	71.52	15.40	11.50	–	7
80390	45	L	–	–	–	W	W	FW	S/O	–	–	22.50	35.50	63.38	–	–	–	2<
80391	52	L	–	–	–	SO	W	W	FW/FW	FW/W	W/J/W	21.80	35.80	60.89	15.20	10.60	–	4

Fig. 8. continued.

*: a or PL is estimated			Tooth Attrition Stage									Measurements (mm) a&PL: see Figure 4			Measurements in mm		Brown and Chapman (1991a, b)	Lowe (1967)
No.	layer	R/L	dp2	dp3	dp4	P2	P3	P4	M1	M2	M3	a	PL	a/PL*100	M1 length	M1 width (on first cusp)	Age (months) based on eruption	Age Class
80392	51	R	–	–	–	Bk	W	FW	HW/HW	FW/W	FW/W/FW	23.70	37.20	63.71	16.20	11.10	–	5
80394	29	R	–	–	–	W	W	W	FW/W	S/O	–	–	–	–	17.00	11.10	–	2<
80395	37	L	–	–	–	W	W	W	HW/HW	FW/W	W/W/FW	23.50	35.30	66.57	15.40	11.00	–	5
80396	52	L	–	–	–	–	–	S/O	HW/HW	FW/FW	FW/FW/FW	–	–	–	15.30	10.40	–	8
80397	12	R	–	–	–	–	–	–	–	S/O	W/J/W	–	–	–	–	–	–	*5
80398	37	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80399	37	R	–	–	–	–	–	–	–	S/O	S/O	–	–	–	–	–	–	–
80400	37	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80401	26	R	–	–	–	–	–	–	S/O	HW/HW	W/FW/FL	–	–	–	–	–	–	8
80402	37	L	–	–	–	Bk	Bk	Bk	Bk	S/O	–	22.70	37.60	60.37	–	–	–	–
80403	40	R	–	–	–	W	W	W	FW/Bk	S/O	–	19.30	34.50	55.94	–	11.10	–	2<
80403	37	R	–	–	–	–	–	–	–	S/O	S/O	–	–	–	–	–	–	–
80405	37	L	–	–	–	–	–	–	Bk	Bk	Bk	–	–	–	–	–	–	–
80406	37	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
80407	54	L	W	W	HW/HW/HW	–	–	–	W/J	H/E	V/–/–	16.90	41.80	40.43	17.30	–	11–13	1
80408	60	L	–	–	–	SO	J	J	W/J	J/J	J/J/H	19.60	43.20	45.37	17.00	11.00	27	2
80409	12	R	W	W	HW/HW/W	–	–	–	J/J	J/J	S/O	19.30	42.10	45.84	16.50	–	15–18	1
80410	30	R	J	W	FW/FW/W	–	–	–	W/J	J/J	V/–/–	18.40	43.70	42.11	17.40	10.70	15–17	1
*80411	51	L	–	–	–	W	W	W	FW/W	W/W	W/J/J	18.70	38.50	48.57			–	2
80412	52	R	W	W	FW/FW/W	–	–	–	W/J	J/J	V/–/–	18.40	41.80	44.02	18.00	–	15–17	1
80413	54	R	W	W	HW/HW/HW	–	–	–	W/J	H/E	V/–/–	16.60	42.50	39.06	17.10	–	11–13	1
80414	37	L	SO	W	Bk	–	–	C	Bk	Bk	S/O	16.80	43.50	38.62	–	–	–	1
80415	52	L	–	–	–	J	W	W	W/W	W/J	W/J/H	19.10	39.40	48.48	16.40	10.50	–	2
80416	37	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU43	40	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU44	40	R	–	–	–	J	Bk	–	–	–	–	20.60	–	–	–	–	–	1–2
JU45	12	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU46	12	R	–	–	–	–	–	S/O	W/FW	Bk	–	–	–	–	16.60	11.60	–	4
JU47	37	R	–	–	–	–	–	–	–	–	S/O	–	–	–	–	–	–	–
JU48	54	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU49	51	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU50	51	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU51	52	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU52	54	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU53	52	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU54	52	L	–	–	–	FL	FW	FW	S/O	–	–	–	37.00	–	–	–	–	3–11

Fig. 8. continued.

*: a or PL is estimated		Tooth Attrition Stage										Measurements (mm) a&PL: see Figure 4			Measurements in mm		Brown and Chapman (1991a, b)	Lowe (1967)
No.	layer	R/L	dp2	dp3	dp4	P2	P3	P4	M1	M2	M3	a	PL	a/PL*100	M1 length	M1 width (on first cusp)	Age (months) based on eruption	Age Class
JU55	24	L	–	–	–	FL	FL	FL	S/O	–	–	24.40	36.30	67.22	–	–	–	12
JU56	50	R	–	–	–	SO	FW	FW	FW/FW	S/O	–	21.70	33.40	64.97	14.30	10.60	–	4/8
JU57	52	R	–	–	–	–	–	–	S/O	J/J	E/E/V	–	–	–	–	–	16–17	1
JU58	51	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU59	37	R	–	–	–	Bk	Bk	Bk	Bk	–	–	–	37.70	–	–	–	–	–
JU60	37	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU61	37	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU62	37	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU64	37	L	–	–	–	–	–	–	–	–	–	–	–	–			–	
JU65	37	R	–	–	–	J	Bk	Bk	s/o	–	–	23.00	38.00	60.53	–	–	–	–
JU66	37	L	–	–	–	–	–	–	–	–	–				–	–	–	–
JU67	37	L	–	–	–	–	–	–	–	–	–	21.00	–		–	–	–	–
JU68	37	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU69	37	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JU70	37	R	–	–	–	FL	FW	FW	HW/HW	FW/FW	FW/FW/FW	20.10	33.10	60.73	15.10	11.50	50<	6
JU71	37	R	–	–	–	–	–	–	FW/W	W/J	W/J/J	–	–	–	16.20	10.50	50	4
JU72	52	L	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Layers - A: Organic deposit under shell layers; B: shell layer; C: collected on the surface

TOOTH ERUPTION AND ATTRITION CODES OF SIKA DEER JAWS
(Based on the codes shown in Legge and Rowley-Conwy 1988: Table 2)

Eruption stages:
C = crypt of permanent premolar below deciduous tooth
V = visible in crypt
E = erupting
H = half erupted
U = full height, unworn

Wear stages:
J = early wear, two crowns of each cusp not united by wear, either on enamel or dentine
W = in wear, two crowns of cusp united by wear at one end (usually anterior)
FW = full wear, infundibulum enclosed by dentine exposed due to wear
HW = heavy wear, infundibulum very reduced, buccal-lingual width of infundibulum less than that of dentine on either side
FL = worn flat, infundibulum eliminated

Others:
SO = empty socket
S/O = empty socket, broken across
Bk = tooth broken where shown

Fig. 8. continued.

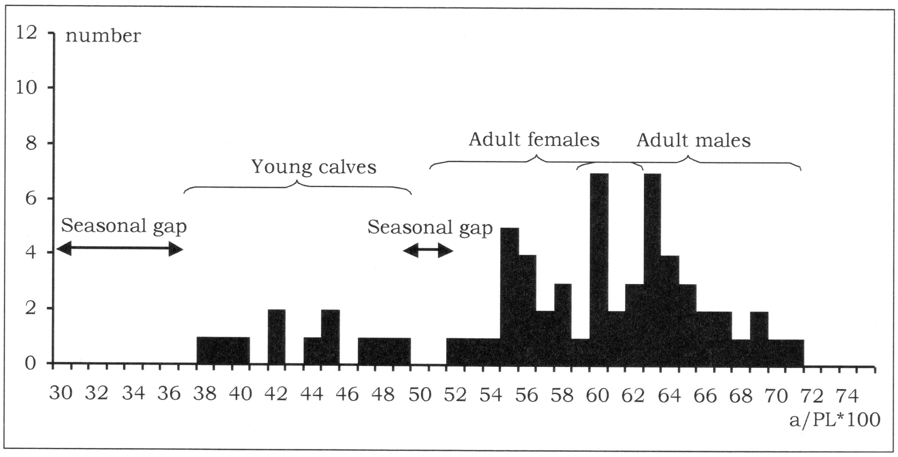

Fig. 9. The a/PL distribution for deer mandibles at Torihama shellmidden. Measurements are those listed in Fig. 8.

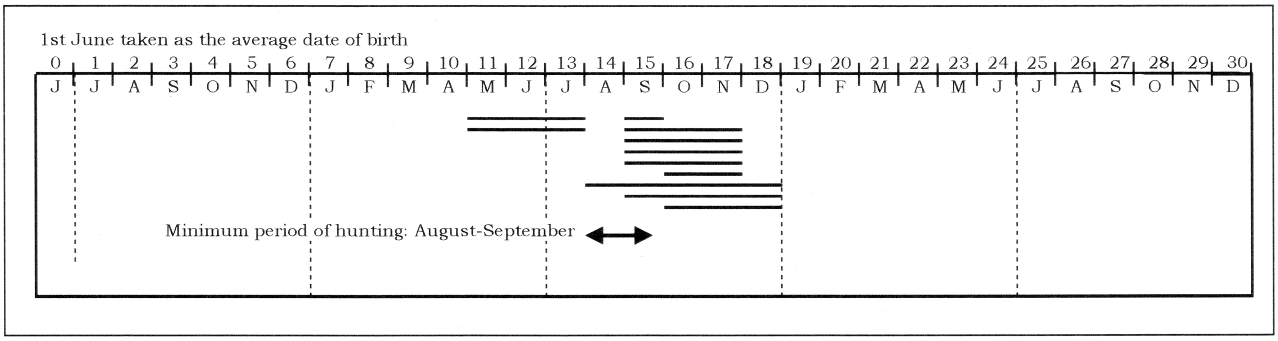

Fig. 10. Sika deer season of death at the Torihama shellmidden based on data presented in Fig. 8. Horizontal axis indicates the number of months after birth that death occurred.

often intact. Dog gnawing marks are rare. These conditions show that this concentration of bones was buried and saturated with water in a comparatively short time after disposal, suggesting that the assemblage represents the original depositional situation stemming from when the shellmidden was formed. Hence, I use this assemblage in order to estimate site function.

For estimating the function of the Torihama shellmidden site, I constructed a utility model predicting large size mammals body part frequencies at sites of various economic function produced in complex forager systems: kill sites, hunting camps, and residential bases. These site types are based on the site formation theory originally presented by Binford (1978a, 1978b, 1980, 1982) and Legge and Rowley-Conwy (1988). Of these, kill sites correspond to Binford's locations, which are formed when small groups of people encounter food resources during trips from residential bases, in this case, trips for hunting (Binford 1980). Hunting camps are defined as temporary operational centres for hunting activities, consistent with this type as described by Binford (1978) and Legge and Rowley-Conwy (1988).

The utility model is shown in Fig. 19. The vertical axis refers to utility indices and the horizontal axis refers to body part frequencies. Thus, if the site functioned as a hunting camp, body parts carrying less meat would be retrieved in higher quantities (dotted line). On the other hand, if the site had been a residential base, there could be two scenarios: more high utility parts would appear in a higher ratio (solid line 1), or, in the case that people tended to bring the whole carcass back, all parts would appear equally (solid line 2). These patterns are widely recognized in ethnographic descriptions of modern hunting groups on the Pacific Rim, e.g. caribou hunting of the Nunamiut Eskimo in Alaska (Binford 1978a, 1978b), wild boar hunting of the Paiwan in Taiwan (Nobayashi 1999), and bear and serow hunting of Matagi hunters in northern Honshu, Japan (Taguchi 1992, 1999). Body part frequencies for Torihama deer are provided in Fig. 20 and represented graphically in Fig. 21, and those of wild boar presented in Figs. 22 and Fig. 23 respectively. Quantification of each body part is represented by means of the percentage of minimum animal units (%MAU) method, placed in line with the MGUI values in the vertical axis. On the supposition that one could expect more or less similar body part values in sika deer and wild boar to those of caribou, I adopted Binford's (1978a, 1978b) modified general utility index (MGUI) values because of the anatomical similarity of deer and wild boar to caribou. The MGUI is a relative utility measure for each body part expressing the value of meat, marrow and grease, taking account of skeletal connections between bone elements. The %MAU is the MAU value for each element expressed as a percentage of the most common element of each species.

Compared with the model, deer and wild boar showed different results. Relatively high %MAU numbers characterize various deer parts, especially the pelvis and those of the axial skeleton (skull, mandible, and vertebrae). In contrast, wild boar show lower %MAU values overall due to the high %MAU values for skulls and mandibles. Such a difference in body part frequencies between deer and wild boar has also been recognized in other reports on Torihama assemblages (Inaba 1983; Shigehara, Hongo and Amitani 1991; based on assemblages belonging to the middle of the Early Jomon excavated in 1972 and 1985, respectively). One might expect some special treatment of wild boar for ritual or religious purposes due to the high frequency of mandibles. However, no other specific evidence, such as a special arrangement of jaws, supports this ritual inference. However, archaeological evidence does exist for the special treatment of animal bones more widely in Japan. For example, at the Mawaki site (Early Jomon, see Fig. 1 for site location) on the Noto Peninsula on the Japan Sea coast of central Honshu, dolphin skulls were arranged in a circle. As for wild boar, mandibles hung on poles through perforations in the ramus have often been found at sites belonging to the Yayoi period (the early agricultural period, 2400–1700 BP).

On the whole, higher MGUI value correlate with high %MAU values for deer, whereas for boar higher %MAU values exist for elements with lower MGUI values. Comparing this pattern with the model presented in Fig. 19, the deer pattern is indicative of a residential base while the wild boar pattern corresponds to a hunting camp.

Torihama Land Use Pattern

Reconstruction of site function for the Torihama shellmidden suggests that this site had a complex economic role in the Early Jomon Period. Torihama functioned simultaneously as a residential base for deer hunting and a hunting camp for wild boar. Considering the results of the seasonality assessments, the functional difference between deer and wild boar exploitation is not as contradictory as it might first appear. The seasonal schedule of subsistence at Torihama indicates that, except for wild boar hunting, all activities were carried out from summer through autumn (Fig. 15). Thus it can be concluded that the Torihama shellmidden was in fact used as a residential base in summer and autumn, while it functioned as a wild boar hunting camp in winter and spring. It is probable that the residential base fissioned and sub-groups moved to small upland sites in winter. Smaller sized Early Jomon sites, with two or at most three dwelling pits, have been regularly found on river terraces in the mountainous areas behind Torihama. The settlement pattern in the Early Phase of the Jomon Period (6000–5000 BP), corresponding to the clumped settlement pattern, is summarized in Fig. 24.

The Torihama shellmidden analysis reveals that people moved their residential base seasonally between the lowlands and mountains. Consequently, the two different environments were connected by seasonal moves and logistical land use. It is noteworthy that freshwater resources like carp family fish could have provided an economic base for large-scale residential camps in the lowlands. It is a common trend for carp family fish and freshwater shells to dominate in faunal assemblages along the southern Japan Sea coast in the Jomon era, as they do in the Torihama shellmidden (Hongo 1989). Most freshwater fish in this area come near to the lakeshore for spawning in early summer, which must have been the best season to acquire a large amount of protein resources. The southern part of Japan was connected with the Asian continent in the middle Miocene (approximately 15 mya) when many freshwater species moved into this part of Japan, but northern Japan was still underwater at that time (Fig. 25).

Zoogeographers in Japan are in general agreement that this resulted in an overwhelming abundance of freshwater fish in southern Japan compared to other parts of the archipelago (e.g., Mizuno 1987; Nakajima 1998; Nishimura 1974). Nishimura (1974, Chapter 5) reports that except for diadromous fish like salmon the present number of freshwater fish species in southern Japan is 46, while there are only 22 species in northern Japan. Of the 22 species in northern Japan, most inhabit flooded lowlands. Nishimura therefore assumed that most of these species were introduced with the expansion of rice paddies in and after the Yayoi period (2400-1700 BP). If so, according to Nishimura's calculations, the original number of native species in northern Japan was only nine. Furthermore, sedimentation has produced many lakes and lagoon environments along the southern Japan Sea coast. Thus, it is quite feasible that freshwater fish played a role as a stable protein resource in the early summer, providing people with the opportunity to remain settled in lowland areas of this part of Japan throughout the Jomon period.

A final question with respect to the functioning of the

· articulated right and left sides (indicated as R/L) measurements were taken on the side that was re intact.

	*:estimated			Tooth Attrition Stage								
No.	layer(層)	R/L	sex	m1	m2	m3	P1	P2	P3	P4	M1	M2
80111	12–24	L	–	–	–	–	–	–	–	–	–	–
80142	12	R	–	–	–	–	–	–	–	–	–	–
80149	A	R	m	–	–	–	U	Bk	Bk	J	FW/FW	W/W
80297	37	L	f	–	–	–	J	W	W	W	FL/FL	HW/FW
80298	37	L	m	–	–	–	–	Bk	Bk	Bk	Bk/Bk	Bk/Bk
80299	52	L	–	–	–	–	–	–	–	S/O	FL/HW	FW/FW
80300	37	R	–	–	–	–	S/O	J	W	W	FW/FW	W/W
80301	51	L	m	SO	SO	FL/FL/FL	–	–	–	–	W/J	V/–
80302	37	L	f	–	–	–	Bk	SO	SO	J	Bk/Bk	J/J
80303	52	R	–	–	–	–	SO	J	W	FW	S/O	–
80304	24	R	–	–	–	–	–	–	–	S/O	FW/FW	J/U
80305	37	L	m	–	–	–	Bk	U	J	W	FW/FW	W/W
80306	12	R	f	W	FW	HW/Bk/Bk	Bk	–	–	–	Bk/Bk	V/–*
80307	40	L	–	–	–	Bk/Bk/FW	–	–	–	–	J/J	V/–
80308	37	R	m	–	–	–	SO	SO	J	J	Bk/Bk	W/J
80309	52	L	–	–	–	–	–	–	–	S/O	HW/FW	W/W
80310	30	R	f	–	–	–	SO	SO	FW	FW	FW/FW	FW/W
80311	52	L	–	–	–	–	–	–	–	J	Bk/FW	J/J
80312	37	R	–	S/O	FW	FW/FW/FW	–	–	–	–	J/J	V/–
80313	52	L	m	–	–	–	SO	J	W	FW	FL/HW	S/O
80314	30	L	–	HW	SO	–	–	–	–	W	HW/FW	J/J
80315	37	R	–	–	–	–	–	–	–	–	–	Bk/Bk
80316	37	L	–	–	–	–	–	Bk	Bk	Bk	Bk/Bk	Bk/Bk
80317	51	R	–	–	–	–	Bk	C	Bk	W	FW/FW	S/O
80318	52	R	f	–	–	–	Bk	C	Bk	H	FW/FW	J/J
80319	29	L	–	–	–	–	–	–	–	–	–	S/O
80320	37	R	–	–	–	–	SO	SO	SO	Bk	Bk/Bk	–
80321	37	R	–	–	–	–	–	Bk	Bk	Bk	S/O	–
80322	37	R	–	–	–	–	–	–	S/O	S/O	Bk	Bk/Bk
80323	52	L	f	–	–	–	SO	J	W	FW	Bk	–
80324	52	R	–	–	–	–	–	–	–	–	–	–
80325	51	R	–	–	–	–	–	–	–	S/O	W/FW	J/J
80326	37	L	–	–	–	–	–	–	–	–	–	–
80327	B	L	–	–	–	–	–	–	–	–	–	–
80328	37	R	–	–	–	–	–	–	–	–	–	–
80329	37	L	–	–	–	–	–	–	–	–	–	–
80330	37	R	–	–	–	–	–	–	–	–	–	–
80331	37	R	–	–	–	–	–	–	–	S/O	Bk/Bk	Bk/Bk
80332	37	L	–	–	–	–	–	–	–	–	–	–
80333	37	R	–	–	–	–	–	–	–	–	–	–
80334	51	R	f	–	–	–	–	–	–	–	–	–
80335	37	R	–	–	–	–	–	Bk	Bk	Bk	Bk/Bk	S/O
80336	37	R	–	–	–	–	–	–	–	–	–	–
80337	52	R	–	–	–	–	–	–	–	–	–	–
80338	37	L	–	–	–	–	–	Bk	Bk	Bk	Bk/Bk	S/O
80340	37	R	m	–	–	–	Bk	E	SO	S/O	–	–
80341	37	L	–	–	–	–	–	S/O	S/O	S/O	S/O	S/O
80342	37	L	m	–	–	–	S/O	E	SO	Bk	FW/FW	Bk/Bk
80343	51	R	f	–	–	–	U	Bk	Bk	W	FW/W	S/O
80344	52	R	–	–	–	–	–	S/O	W	FW	HW/HW	FW/FW
80345	12	R	–	–	–	–	–	Bk	W	W	HW/FW	W/W
80346	30	L	f	–	–	–	Bk	FW	SO	J	HW/FW	W/J
80347	31	R	–	–	–	–	–	S/O	U	J	FW/FW	J/J

Fig. 11. Wild boar mandible data from Torihama shellmidden.

	Grant(1982)				Higham (1967)						
	TWS			MWS	Stage	Age (months)	Measurements in mm		M3 size		
M3	M1	M2	M3	Total	Appendix B	based on eruption	M1 length	M1 width (on first cup)	length	width	NB
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
V/V/–	e	c	V	20	18	17–19	16.90	10.40	–	–	–
J/J/U	l	e	a	31	–	–	14.70	10.20	–	15.90	–
J/H/E	–	–	1/2	24to28	20	21–23	–	–	–	–	–
W/W/W	g	f	c	31	–	–	17.2*	11.3*	38.00	17.80	–
S/O	e	c	–	21*	–	–	16.20	10.00	–	–	–
–	b	C	–	8	10	8–9	17.60	10.50	–	–	–
S/O	–	a	–	16to20	–	–	16.80	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
V/–/–	d	a	V	17	15–17	14–17	17.20	10.90	–	–	–
S/O	f	c	–	24or25	–	–	16.40	10.20	–	–	–
–	–	V	–	8to14	–	–	–	–	–	–	–
–	a	V	–	8	10	8–9	19.00	11.70	–	–	–
E/V/–	–	b	E	22or23	19	19–21	17.40	–	–	–	–
J/J/H	f	d	a	26	20	21–23	17.00	9.80	–	15.40	–
J/J/E	e	d	a	25	20	21–23	15.80	11.20	38.70	17.10	–
V/V/–	e	a	V	18	18	17–19	16.40	10.70	–	–	–
–	a	C	–	7	10	8–9	16.60	10.60	–	–	–
–	–	–	–	18to31	–	–	–	–	–	–	–
S/O	f	a	–	21*	–	–	16.50	10.20	–	–	–
V/V/–	–	–	V	16to22	18	17–19	–	–	–	–	–
Bk/H/E	–	–	1/2	24to28	20	21–23	–	–	–	–	–
–	–	–	–	16to19	–	–	18.30	11.70	–	–	–
V/–/–	d	a	V	17	16	15–16	18.00	10.40	–	–	–
U/H/E	–	–	–	25to28	20	21–23	–	–	31.20	15.90	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
S/O	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	18to28	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
S/O	d	a	–	17	–	–	18.40	11.90	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
Bk/Bk/H	–	–	1/2	23to26	20	21–23	–	–	38.00	–	–
S/O	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	16	15–16	–	–	–	–	–
J/J/H	–	–	1/2	23to26	20	21–23	–	–	38.80	16.80	–
S/O	e	–	–	14to23	16	15–16	18.30	11.10	–	–	–
Bk/Bk/Bk	e	–	–	22or23	–	–	16.70	9.80	–	–	–
W/J/J	h	e	b	30	–	–	15.40	10.70	37.5*	17.20	–
H/E/–	f	c	E	22	19	19–21	16.60	10.80	–	–	–
V/–/–	f	a	C	18	17	16–17	16.40	10.10	–	–	–
V/–/–	e	a	C	17	17	16–17	16.60	10.10	–	–	–

	*:estimated			Tooth Attrition Stage								
No.	layer(層)	R/L	sex	m1	m2	m3	P1	P2	P3	P4	M1	M2
80348	52	R	–	–	–	–	–	S/O	W	W	FL/FW	W/W
80349	54	L	–	FW	FW	HW/HW/FW	SO	–	–	–	FW/W	V/V
80350	12	L	–	–	S/O	Bk/Bk/FW	–	–	–	–	W/J	V/–
80351	B	R	m	–	–	–	S/O	U	J	SO	FW/W	J/J
80352	B	R	m	–	–	–	–	Bk	W	FW	HW/HW	FW/FW
80353	40	L	f	–	–	–	–	J	W	W	HW/FW	FW/W
80354	60	R	–	–	–	–	–	–	S/O	W	FW/FW	W/J
80355	52	R	m	–	–	–	SO	SO	W	W	FL/FL	FW/W
80399	60	L	–	–	–	–	–	–	–	–	S/O	W/W
JUS60	37	L	–	W	FW	HW/Bk/Bk	–	–	–	–	Bk	V/V
JUS61	?	R/L	f	FW	Bk	FL/FL/FL	W	–	C	C	HW/FW	J/J
JUS62	52	R	m	–	–	–	–	–	–	–	–	–
JUS63	52	R	–	–	–	–	–	–	–	–	S/O	J/J
JUS64	40	L	–	W	FW	FW/HW/FW	SO	–	–	–	W/H	–
JUS65	51	L	–	–	–	–	–	–	–	–	–	S/O
JUS66	51	L	f	–	–	–	Bk	SO	SO	S/O	–	–
JUS67	49	R	m	–	–	–	Bk	Bk	Bk	FW	S/O	–
JUS68	51	L	–	–	–	–	–	–	–	–	–	–
JUS69	49	R	–	–	–	–	–	–	–	–	–	–
JUS70	49	L	–	–	–	–	–	–	–	–	–	–
JUS71	60	L	–	–	–	–	–	–	–	–	–	–
JUS72	31	R	–	–	–	–	–	–	–	–	–	–
JUS73	37	R/L	–	FW	FW	FW/FW/FW	–	–	–	–	J/J	V/V
JUS74	37	L	–	–	–	–	–	–	–	Bk	Bk	Bk
JUS75	37	R	–	–	–	–	SO	SO	SO	S/O	–	–
JUS76	37	R	–	–	–	–	–	–	–	–	–	–
JUS77	37	L	–	S/O	S/O	S/O	–	–	–	–	S/O	V/–
JUS78	37	L	–	–	–	–	–	S/O	S/O	S/O	S/O	S/O
JUS79	37	R	–	–	–	–	–	–	–	–	–	–
JUS80	37	R	–	–	–	–	–	–	–	–	–	–
JUS81	37	R	–	–	–	–	–	–	–	–	–	–
JUS82	37	R	–	–	–	–	–	–	–	–	–	–
JUS83	37	R	–	–	–	–	–	–	–	–	–	–
JUS84	37	R	–	–	–	–	–	–	–	–	–	–
JUS85	37	L	–	–	–	–	–	–	–	–	–	–
JUS86	37	R	m	–	–	–	–	–	–	–	–	–
JUS87	37	R	–	–	–	–	–	–	–	–	–	–
JUS88	37	B	–	–	–	–	–	–	–	–	–	–
JUS89	37	R	–	–	–	–	–	–	–	–	–	–
JUS90	37	L	–	–	–	–	–	–	–	–	–	–
JUS91	37	L	–	–	–	–	–	–	–	–	–	–
JUS92	37	L	–	–	–	–	–	–	–	J	–	–
JUS93	37	R	–	–	–	–	–	–	C/U	–	–	–
JUS94	37	L	–	–	–	–	–	–	C/U	–	–	–
JUS95	37	R	f	–	–	–	–	–	–	–	–	–
JUS96	37	L	–	–	–	–	–	–	–	–	–	–
JUS97	37	R	–	–	–	–	–	–	–	–	–	–

Layers: A: Organic deposit under shell layers;
B: shell layer

TOOTH ERUPTION AND ATTRITION CODES OF WILD BOAR JAWS
(Uchiyama 2002a: Figure 10)

Eruption stages:
C= crypt of permanent premolar below deciduous tooth.2
V= visible in crypt.
E= erupting.
H= half erupted.
U= full height, unworn.

Fig. 11. continued.

	Grant(1982)				Higham (1967)						
	TWS			MWS	Stage Appendix B	Age (months)	Measurements in mm		M3 size		
M3	M1	M2	M3	Total		based on eruption	M1 length	M1 width (on first cup)	length	width	NB
W/J/U	f	c	b	26	–	–	16.60	9.40	37.60	15.60	–
–	c	V	–	10	11	9–10	17.60	10.80	–	–	–
–	b	V	–	9	9–10	7–9	18.00	11.00	–	–	–
V/V/–	d	a	V	17	18	17–19	17.20	10.20	–	–	–
J/J/H	h	d	a	28	20	21–23	17.60	11.40	–	16.80	–
J/J/H	f	d	a	26	20	21–23	16.00	10.80	–	15.80	–
U/U/H	e	b	a	23	20	12–17	16.80	10.20	–	14.60	–
J/H/–	j	d	1/2	27	20	21–23	17.50	11.20	–	17.20	–
U/H/E	–	c	1/2	23to25	20	21–23	–	–	39.40	17.30	–
–	–	C	–	6–10	11	9–10	–	–	–	–	–
V/–/–	f	a	C	18	14–17	12–17	16.10	9.80	–	–	measurement: left
–	–	–	–	–	–	–	–	–	–	–	–
V/V/–	–	a	V	16–18	18	17–19	–	–	–	–	–
–	b	V	–	9	8	6–7	18.50	10.80	–	–	–
V/V/–	–	–	V	16–24	18	17–19	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	P2 erupting socket
–	–	–	–	26–40	–	–	–	–	–	–	–
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S/O	–	–	–	–	–	–	–	–	–	–	–
V/–/–	–	–	C/V	10–24	–	–	–	–	–	16.80	–
–	b/c	C	–	8/9	11	9–10	19.40	11.30	–	–	measurement: right
S/O	–	–	–	–	–	–	–	–	–	–	–
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Bk	–	–	–	–	–	–	–	–	–	–	–
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?/?/EorH	–	–	–	–	20	21–23	–	–	–	–	–
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Wear stages:
J= early wear, enamel declined.
W= in wear, dentine exposed.
FW= full wear, buccal-lingual width of dentine still less than that of occucal face of each cusp, but dentine areas of crowns of each cusp partially contact each other.
HW= heavy wear, cusps very reduced, dentine areas of crowns of each cusp united by wear. The buccal-lingual width of dentine is now getting larger than that of occucal face of each cusp.
FL= worn flat, crown eliminated.

Others:
SO= empty socket.
S/O= empty socket, broken across.
Bk= tooth broken where shown.

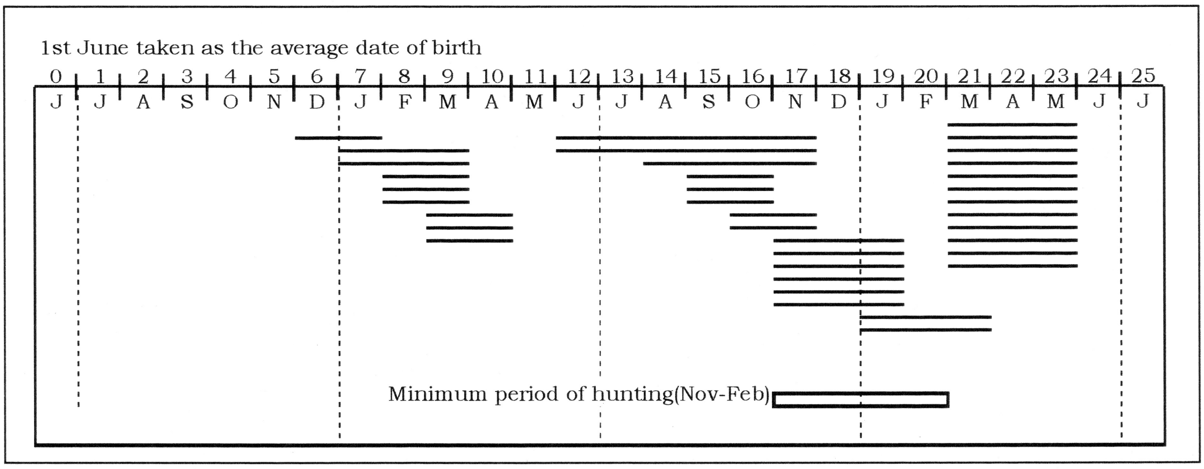

Fig. 12. Wild boar season of death at the Torihama shellmidden based on data presented in Fig. 11. Horizontal axis indicates the number of months after birth that death occurred.

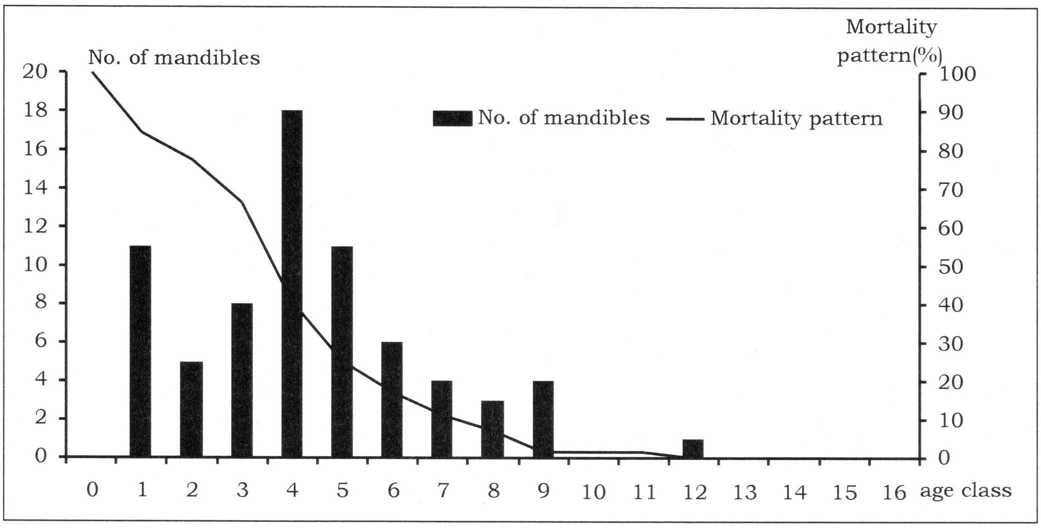

Fig. 13. Deer age structure and mortality pattern at Torihama shellmidden.

Torihama settlement during the clumped period is: why did people go on using the site as a wild boar hunting camp in cold seasons? Human environmental impact within the site area may provide an answer this question. As a result of human residence and activity in the summer, open land and secondary forests must have formed around the site, as several paleoethnobotanical analyses on the Torihama shellmidden have indicated (Nishida 1980, 1981; Yasuda 1978, 1979). This modified environment was probably favoured by omnivorous animals like wild boar. Human groups probably deliberately exploited this situation for greater hunting success.

Discussion and Conclusion: The Causes of Land Use Change

If the Torihama clumped land use pattern can be described as successful strategy for making a living, what factors caused the ultimate shift away from this pattern? The Torihama site itself continued to be used, but the end of the deposition of shell layers and the drastic decrease in archaeological materials suggest that both the scale and population of the site was rapidly reduced at the end of the Early Jomon Period around 5500-5000 BP. The size of the site was reduced to almost as small as the other modest sites sparsely distributed throughout the area. With the reduction in site size, the settlement pattern changed from the previous clumped type into a dispersed

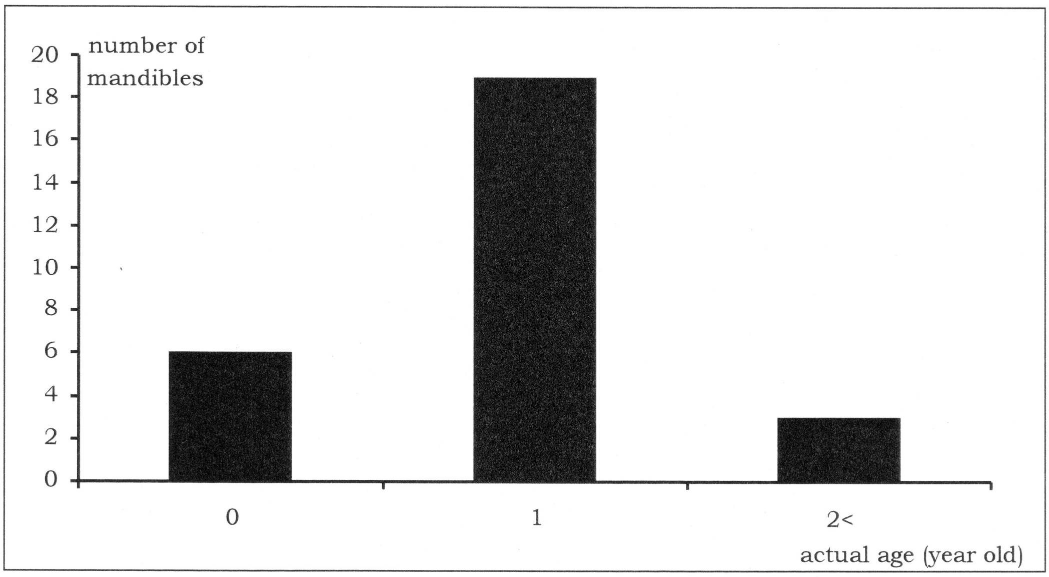

Fig. 14. Age structure of wild boar at Torihama shellmidden.

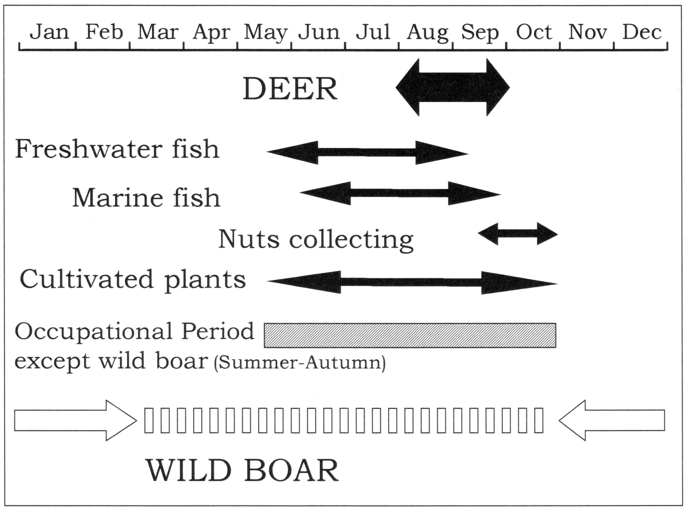

Fig. 15. Reconstructed seasonal scheduling of activities at Torihama shellmidden (6000–5500BP).

pattern. Considering these facts together, it seems that resource harvesting became much less intensive and the scope of resource acquisition around the Torihama site shrank considerably. The former logistical range around the site incorporated different environmental zones strongly connected through the core centre at Torihama. In the ensuing dispersed pattern, it appears that logistical excursions from Torihama itself virtually ceased.

Several propositions can be made regarding the cause of the change in land use pattern. First, due to some kind of environmental deterioration, such as climate change, it may have become more difficult to maintain the high level of aggregation of population supported by the clumped settlement pattern. For example, Yasuda (1990, 171–89) considered that Jomon society was faced with an overall "crisis" at the end of the Early Phase (5000 BP) caused by a sudden fall in sea level. Yasuda argued that this phenomenon eliminated the inner bay environments on which the Jomon economy was based. However, recent studies do not necessarily support such a sudden change in environment. Certainly sea levels did fluctuate; there now seems to be general agreement that from the end of the last glacial age seas level rose to several metres higher than today by roughly 6000 BP. Levels then started to drop gradually to the present level throughout the Early Jomon (e.g., Endo 1999) (Fig. 26).

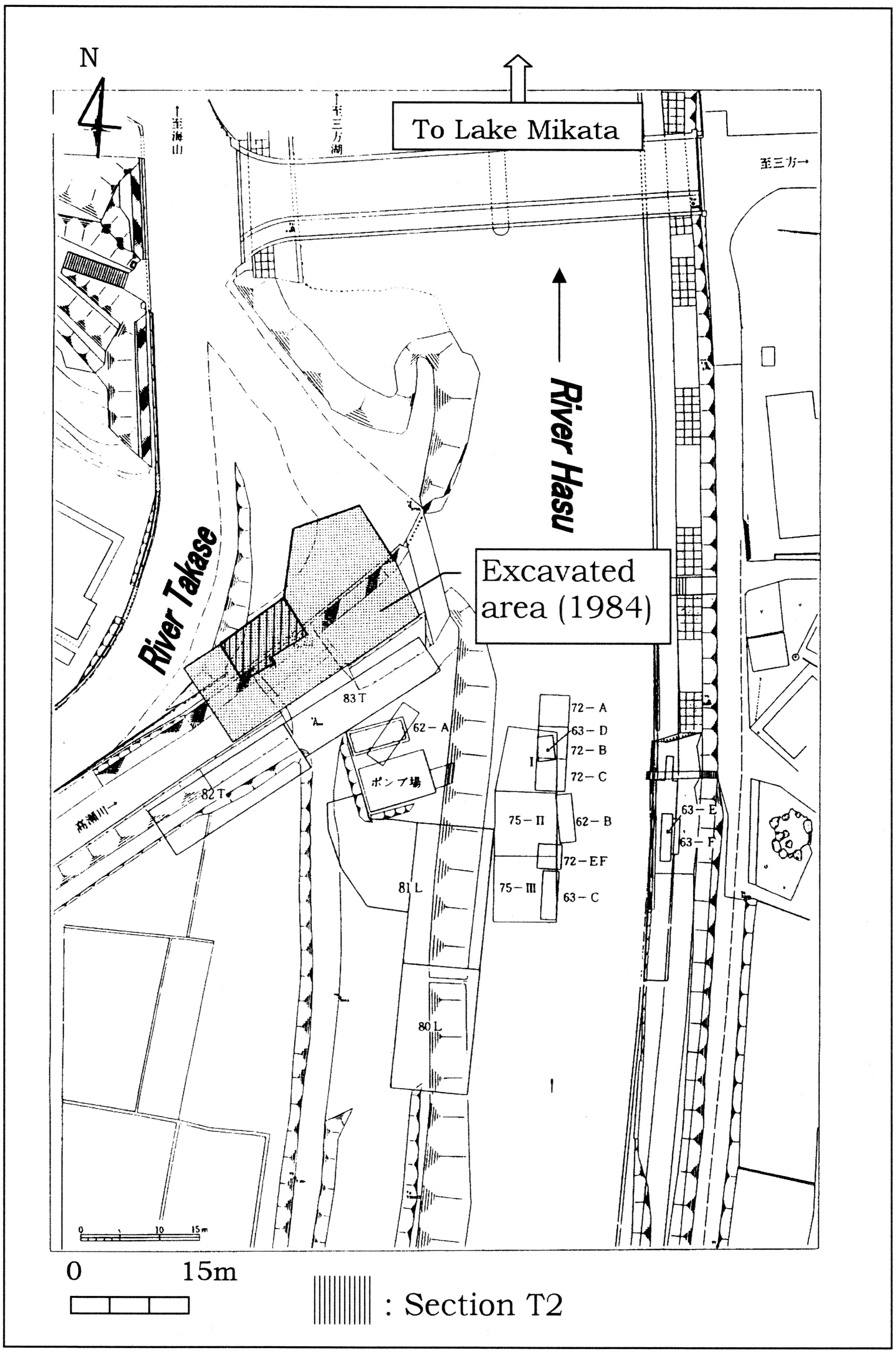

Fig. 16. Plan of the Torihama site and excavations in 1984, modified from Research Group for Torihama Shellmidden (1985, Fig. 2).

Even so, it should be noted that the sea level regression was not a sudden occurrence but a gradual process inconsistent in timing pace to the settlement pattern shift at Torihama. Adding to this, there are at least two points suggesting that this environmental change could not have made an impact strong enough to cause wholesale change in settlement patterns in southern Japan at that time:

(1) Based on Akazawa's (1986) notion that large settlements located at ecotones constituted the key node of the Jomon economy, Yasuda (1990) considered that the disappearance of inner bays led to a "combined forest-estuary ecosystem" (Akazawa 1986, 79). It should be noted that this hypothesis could be applied only to the Kanto plain, i.e., the coastal areas of Tokyo Bay (see Fig. 1 for location), but not to the

Class	Species	Latin name	NISP	MNI	(*Italics* denote right sides.)	total MAU
Mammalia	Sika deer	*Cervus nippon*	621	19	(Radius)	449.63
Mammalia	Wild boar	*Sus scrofa*	206	17	(*Mandibles*)	161.63
Osteichthyes	Bluefin tuna	*Thunnus thynnus*	21	1	(Vertebrae)	2.16
Mammalia	Asian black bear	*Ursus thibetanus*	7	1	(Pelvis, *pelvis*, metacarpus, *metacarpus*, *mandible*, sacrum)	7.4
Mammalia	Dog	*Canis familiaris*	10	2	(*Frontales* & *maxillae*)	8
Mammalia	Japanese serow	*Capricornis crispus*	5	1	(Scapula, metatarsus, *humerus*, *maxilla*, thoracic)	4.15
Aves	Hawk	*Accipitidae sp. indet*	5	1	(*Metacarpus* & *scapula*, scapula, sternum)	5
Mammalia	Japanese monkey	*Macaca fuscata*	3	2	(Humerus)	2
Aves	Green-winged/falcated teal	*Anas sp. indet*	2	1	(Humerus & ulna)	2
Mammalia	Racoon dog	*Nyctereutes procyonoides*	1	1	(*Mandible*)	1
Aves	Heron	*Ardeidae gen. et sp. indet*	1	1	(*Metatarsus*)	1
Aves	Mallard	*Anas sp. indet*	1	1	(Coracoid)	1
Aves	Pheasant	*Phasianus sp. indet.*	1	1	(*Tibia*)	1
Aves	Swan	*Cyngus sp. indet*	1	1	(Metacarpus)	1
Osteichthyes	Wrasse	*Semicossyphus reticlatus*	1	1	(Lower pharyngeal)	2
Osteichthyes	Perch	*Lateolabrax japonicus*	1	1	(Opercle)	1
		Total	887	52		

Fig. 17. Representation of major species in the Torihama shellmidden.

southern Japan Sea coastlines. As Akazawa noted, the Kanto region is characterized by flat diluvial uplands, with alluvial lowlands along the coast. In particular, it should be pointed out that a great many shell middens and other types of occupation sites were formed during the early and mid Holocene marine transgression in these coastal regions. At this time great embayments, surrounded by much longer coastlines, existed. These embayments were generally formed far inland, with no direct influence from oceanic currents (Akazawa 1986,79). As mentioned previously, lagoons and lakes characterize the southern Japan Sea coast and the Jomon economy there is believed to have been based on freshwater resources. Thus one could not expect much if any economic change in this area, even if a sudden regression of sea level occurred at that time.

(2) Not only the number but also the general scale and size of shellmiddens greatly increased from the Early Jomon until the Late Jomon, even in the Kanto region (Fig. 27). Shellmidden deposits often reached more than two metres in thickness and took the shape of a doughnut of more than 200 metres in diameter. In areas other than the Kanto, for example in the northernmost part of Honshu and southern Hokkaido, large-scale settlement sites were formed from the middle Early Jomon until the end of the Middle phase. As seen in Fig. 5, land use in this area changed from the former dispersed pattern into a clumped one. At that time several large settlements like San'nai-Maruyama were accompanied by a massive quantity of archaeological remains including more than 500 dwelling pits.

These observations underscore the point that environmental change did not always have a negative effect and also suggest that change in settlement pattern shifts did not necessarily happen instantly in response to environmental shifts.

A second hypothesis concerning the settlement pattern change relates to inter-societal conflict. Conflict with other groups may have occurred for various reasons such as a breakdown of sharing agreements for resource patches. However, the archaeological evidence does not support this hypothesis, although some style changes and cultural influence from other areas can be observed in the types of pottery and other artefacts, especially those from the upper part of the shell-bearing and later layers. However, such changes in material culture happened quite gradually without any cultural hiatus or instantaneous replacement. Thus the cultural change was not the drastic phenomenon that we might expect in the case of a shift or replacement in population as a result of conflicts with other local groups. For instance, some exotic design patterns became more frequently used on pottery from the uppermost layers of the shellmidden, showing cultural influence of the northern part of Honshu areas. Even so, the basic local forms and styles persisted, suggesting considerable cultural continuity from the lower layers. This influence of northern Honshu culture can be seen in other artefacts like stone adze shafts and also in the lacquer coating technique on pottery. Interestingly, northern Honshu pottery came to include design patterns that developed in the southern Honshu area, including the Torihama site (Katsuhiko Amitani [Professor of Archaeology, Department of Japanese History, Junior College of Tsuruga], personal communication, December 24, 2004). Consequently, the exchange of pottery designs and tool-making techniques suggests cultural exchanges and thus interactions became more prevalent throughout the Honshu Island from the Early to Middle phases rather than indicative of societal conflicts between local populations.

If exogenous environmental change and inter-societal conflict seem insufficient to explain settlement pattern shifts at the end of the early Jomon Period, a compelling potential explanation may be human induced environmental degradation. This seems most probable and feasible, since even foragers can have a considerable impact on their surroundings. There is no direct evidence to establish this as key at the moment. However, the analysis of tree pollen suggests that human groups significantly altered the natural vegetation around Torihama. Yasuda investigated the transition of vegetation through shifts in tree pollen proportions in core samples extracted at the Torihama site (Yasuda 1979) and from Lake Mikata, a freshwater lake north of the site (Yasuda 1982; see Fig. 6 for the location of Lake Mikata). The site sample reflected the environmental situation of the site area, whereas the lake sample reflected the vegetation of the hinterland of the site. Comparing these two records, several differences can be observed between the floral situations in and around the site (Fig. 28 and 29). Analysis of a sample from the lake deposits indicated that beech family trees, in particular beech (*Fagus* sp.) and oak (*Quercus* sp.), were basic species in the forests of the site hinterland. However, as human occupation started and became more intensive in the later Initial phase (9000-6000 BP), beech family pollen drastically decreased in the site area. This means that people may intentionally have cut or burnt the original vegetation to make open land for occupation.

On the other hand, cedar (*Cryptomeria* sp.) took on a different aspect. Cedar pollen tended to increase both in the site area and the surrounding forests from the very beginning of human occupation in the early Initial Jomon (c. 11,000 BP). This tendency is clearly evident in the site area during the Torihama clumped period, but increases are not so clear in the hinterland. Cedar ultimately contributed almost 50% of total pollen, becoming the dominant tree in the site area in the latter half of the clumped period, yet remained at 20% in the hinterland forests. Cedar can adapt well to frequently flooded land with rocky and sandy soil (Touyama 1976, 215). Therefore, its increased frequency strongly suggests that land under intensive use and development gradually became poorer in quality as a result of continuous deforestation of beech and oak trees. A large proportion of sandy soil is evident in layers corresponding to the clumped period at Torihama, suggesting frequent floods and debris-avalanches (Yasuda 1990, 166-9). These data support the theory that deforestation has a negative impact on the environment around the site at that time. Such a process of deforestation could have at least partially been promoted by population pressure; increasing population at a large, central residential base may have rendered the environment around the site ultimately unable to support the clumped land use pattern (Fig. 30). In all likelihood, an increasing number of floods promoted the sedimentation of lakes, which made the area less attractive for the freshwater fish species that formed the settlement's economic base.

Human impact on the environment has been neglected in recent studies of complex foragers. There is no doubt that settlement pattern change, particularly in the case of the change from a clumped to dispersed pattern in Jomon Japan, may have been triggered by climate change or by conflicts with other social groups. As shown in Fig. 5, settlement pattern change occurred several times during the Jomon era. This indicates that factors other than human impact may have had more significance in other cases of land use pattern change. Even so, the case of Torihama suggests that human impact on the local environment played an important role in the changes in settlement pattern that occurred in the southern Japan Sea coast area at the end of the Early Jomon. Hence, the view of humans as environmental "troublemakers" should receive more emphasis in future studies of long-term changes in hunter-gatherer lifeways.

Acknowledgments

I wish to express my thanks to Katsuhiko Amitani, who provided useful advice based on his role as a chief member of the Torihama excavations (1972–1985), and also to the Fukui Prefectural Museum of History for permission to analyse the Torihama remains. Discussions with Shuzo Koyama and Tsuneo Nakajima have been extremely helpful. Also, I thank Shinji Seguchi for providing useful details of his work for the construction of Fig. 5.

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Junzo Uchiyama
Research Institute for Humanity and Nature (RIHN)
335 Takashima-cho,
Kamigyo-ku,
Kyoto 602–0878
Japan
E-mail: junzo@chikyu.ac.jp

Appendix

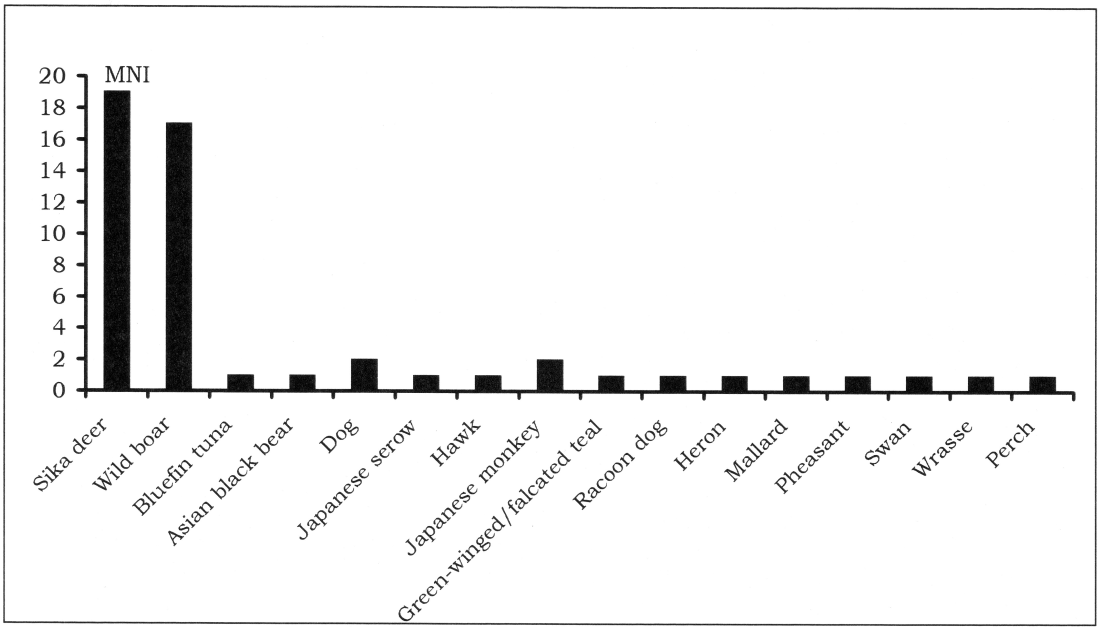


Fig. 18. MNI values for major species represented at the Torihama shellmidden based on data from Fig. 17. Taxa are ordered along the horizontal axis according to NISP values.

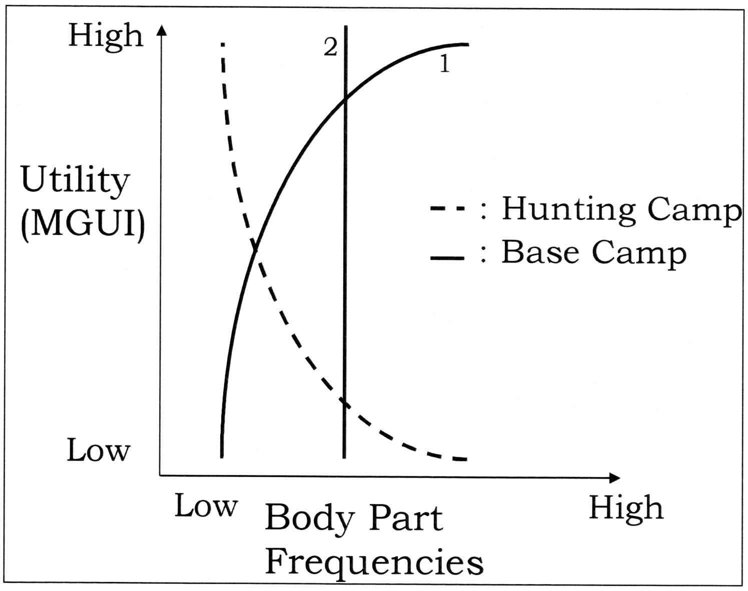


Fig. 19. Model of utility illustrating predictable patterns of anatomical part frequency representation for medium/ large-size mammal remains with respect to the economic function of sites.

		MNE			MAU	%MAU(pr&pelv=100)
Element	Abbrev.	R		L		
mandible	man	9	–	12	21.00	70.00
maxilla	sk	6	–	4	10.00	33.33
atlas	at	–	8	–	16.00	53.33
axis	ax	–	13	–	26.00	86.67
cervical vertebrae 3–7	cer	–	59	–	23.60	78.67
thoracic vertebrae	thor	–	37	–	5.69	18.97
lumbar	lumb	–	67	–	22.33	74.44
scapula	scap	8	–	8	16.00	53.33
proximal humerus	ph	7	–	6	13.00	43.33
distal humerus	dh	12	–	15	27.00	90.00
proximal radius	pr	11	–	19	30.00	100.00
distal radius	dr	7	–	9	16.00	53.33
pelvis	pelv	17	–	12	29.00	96.67
proximal femur	pf	11	–	12	23.00	76.67
distal femur	df	9	–	13	22.00	73.33
proximal tibia	pt	9	–	10	19.00	63.33
distal tibia	dt	7	–	8	15.00	50.00
astragalus	ast	3	–	7	10.00	33.33
calcaneum	calc	4	–	7	11.00	36.67
navicula–cuboid	n–v	1	–	2	3.00	10.00
proximal metacarpal	pmc	3	–	3	6.00	20.00
distal metacarpal	dmc	9.5	–	9.5	19.00	63.33
proximal metatarsal	pmt	5	–	3	8.00	26.67
distal metatarsal	dmt	4	–	2	6.00	20.00
phalanges1	phal1	–	39	–	9.75	32.50
phalanges2	phal2	–	28	–	7.00	23.33
phalanges3	phal3	–	9	–	2.25	7.50
sacrum	sac	–	6	–	12.00	40.00

Minimum number of elements: 570
MAU total(+21 skulls): 449.63

Fig. 20. Body part representation for sika deer in the Torihama shellmidden.

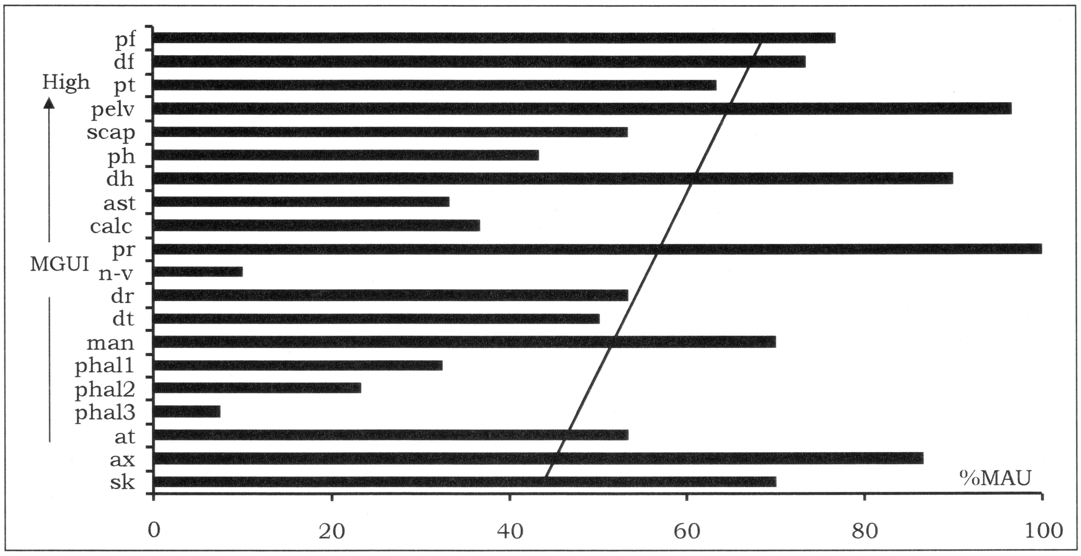


Fig. 21. Frequency of deer bones at the Torihama shellmidden expressed as percent MAU and re-ordered to conform to MGUI order, based on data presented in Fig. 20. Metapodials are omitted due to their high utilisation as bone tool raw material.

		MNE			MAU	%MAU(md=100)
Element	Abbrev.	R		L		
mandible	man	17	–	14	31.00	100.00
maxilla	sk	10	–	6	16.00	51.61
atlas	at	–	4	–	8.00	25.81
axis	ax	–	2	–	4.00	12.90
cervical vertebrae 3–7	cer	–	10	–	4.00	12.90
thoracic vertebrae	thor	–	13	–	1.86	5.99
lumbar	lumb	–	24	–	8.00	25.81
scapula	scap	3	–	2	5.00	16.13
proximal humerus	ph	2	–	1	3.00	9.68
distal humerus	dh	3	–	3	6.00	19.35
proximal radius	pr	3	–	2	5.00	16.13
distal radius	dr	2	–	3	5.00	16.13
pelvis	pelv	3	–	6	9.00	29.03
proximal femur	pf	2	–	1	3.00	9.68
distal femur	df	3	–	1	4.00	12.90
proximal tibia	pt	2	–	4	6.00	19.35
distal tibia	dt	3	–	5	8.00	25.81
astragalus	ast	1	–	2	3.00	9.68
calcaneum	calc	3	–	1	4.00	12.90
navicula–cuboid	n–v	2	–	1	3.00	9.68
proximal metacarpal	pmc	3	–	0	3.00	9.68
distal metacarpal	dmc	1	–	2	3.00	9.68
proximal metatarsal	pmt	0	–	0	0.00	0.00
distal metatarsal	dmt	0	–	0	0.00	0.00
phalanges1	phal1	–	6	–	1.50	4.84
phalanges2	phal2	–	2	–	0.50	1.61
phalanges3	phal3	–	2	–	0.50	1.61
sacrum	sac	–	0	–	0.00	0.00

Minimum number of elements = 182
MAU total (+16 skulls) = 161.36

Fig. 22. Body part representation for wild boar in the Torihama shellmidden.

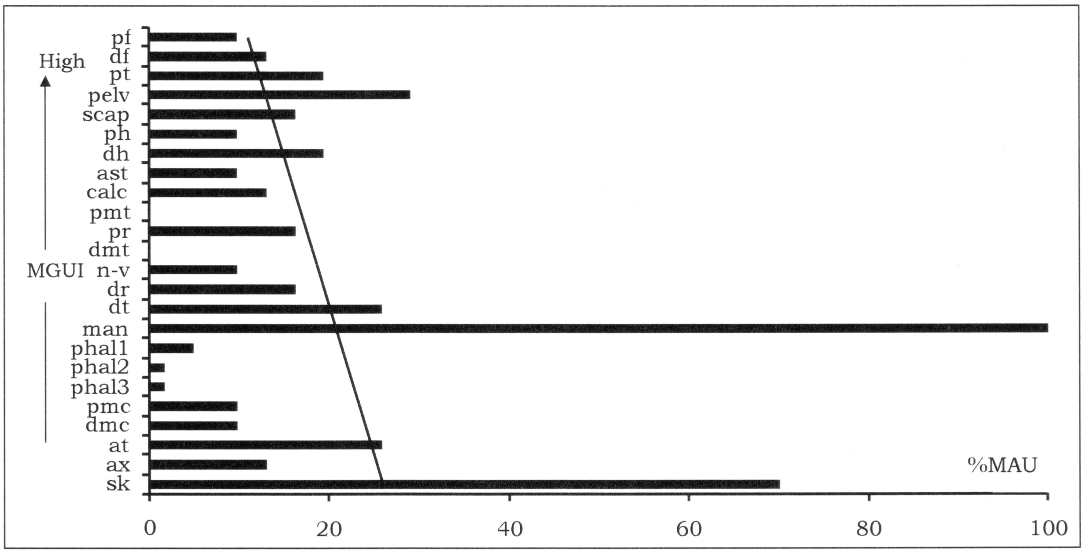


Fig. 23. Frequency of wild boar bones at the Torihama shellmidden expressed as percent MAU and re-ordered to conform to the MGUI order, based on data presented in Fig. 22.

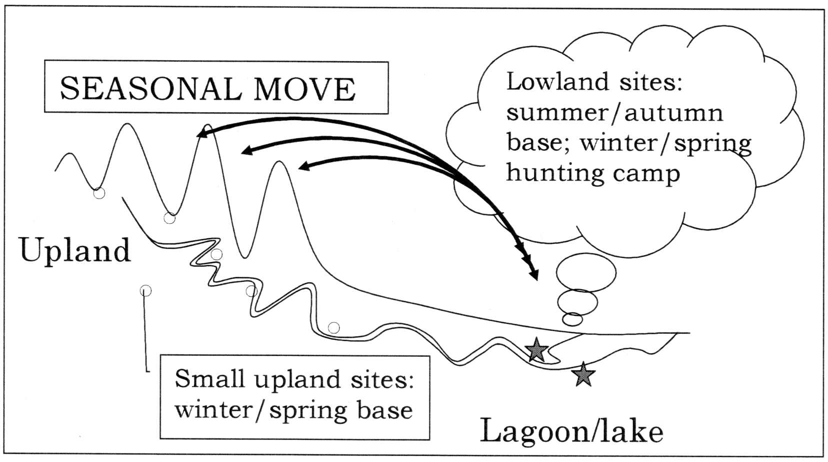

SEASONAL MOVE
Lowland sites: summer/autumn base; winter/spring hunting camp
Upland
Small upland sites: winter/spring base
Lagoon/lake

Fig. 24. Reconstructed land use pattern in the Torihama shellmidden site vicinity circa 6000–5500 BP.

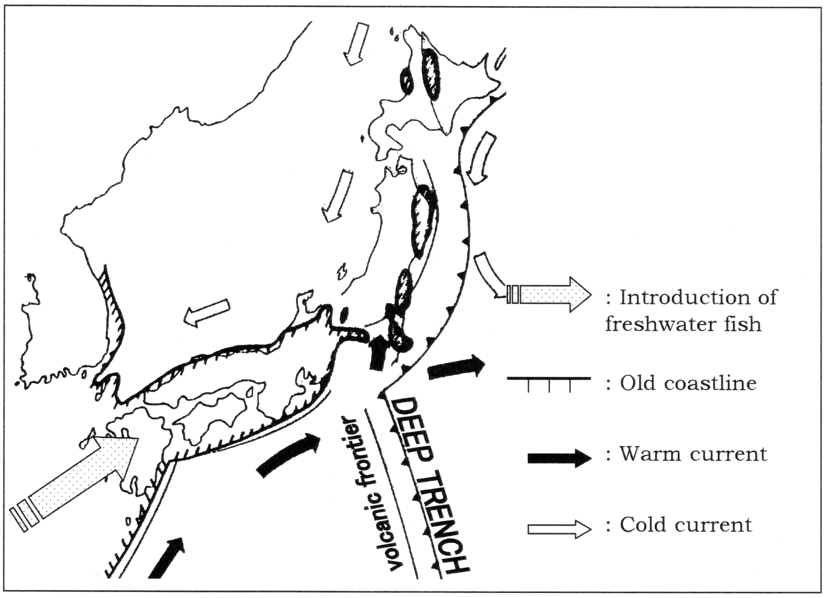


Fig. 25. Miocene coastline of the Japanese Islands (13 mya), adapted from Editorial Committee of Geological Features of the Japanese Islands (1996, 52).

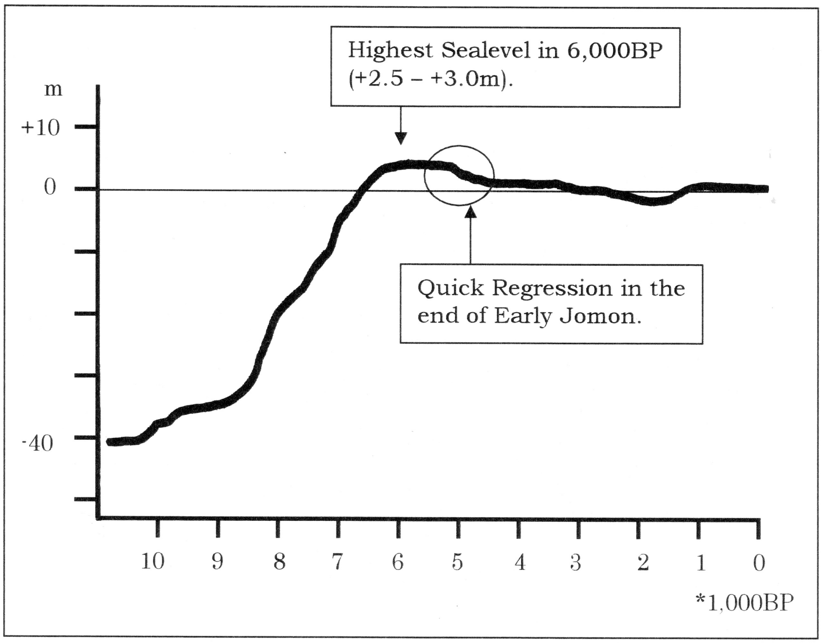


Fig. 26. Sea level change in the central Kanto Plain during the last 11,000 years, modified from Endo (1999, Fig. 6).

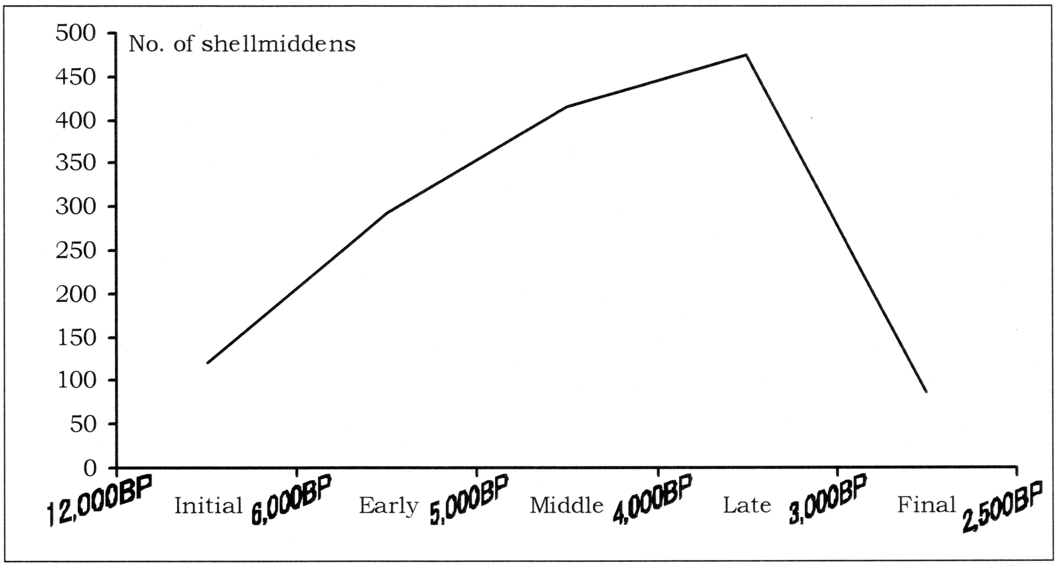


Fig. 27. Number of Jomon-age shellmiddens in the Kanto Region (32,419 sq. km), based on data from Uchiyama (1997, Fig. 2).

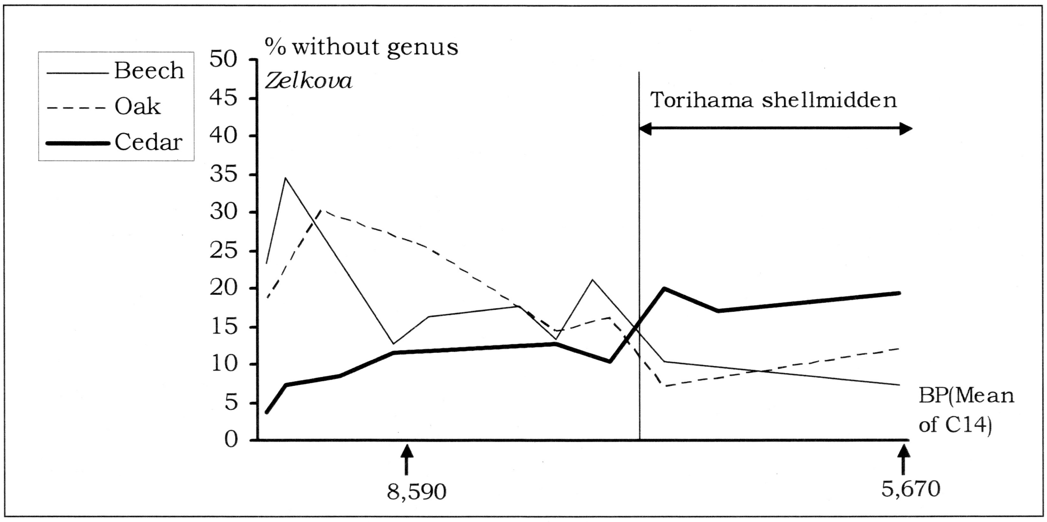


Fig. 28. Vegetation shifts in the Torihama hinterland region between 11,000–5500 BP, adapted from Yasuda (1990, Fig. 40). Vertical line indicates pollen percentages excluding the genus Zelkova, a pervasive species of freshwater plant in Japan.

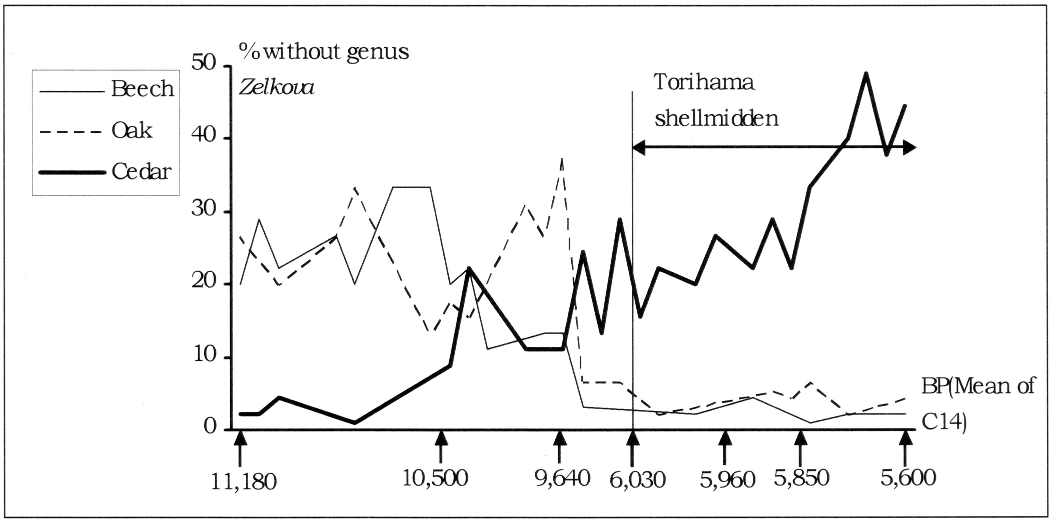


Fig. 29. Vegetation shifts in the Torihama immediate site region between 11,000–5500 BP, adapted from Yasuda (1990, Fig 39). Vertical line indicates pollen percentages excluding the genus Zelkova, a pervasive species of freshwater plant in Japan.

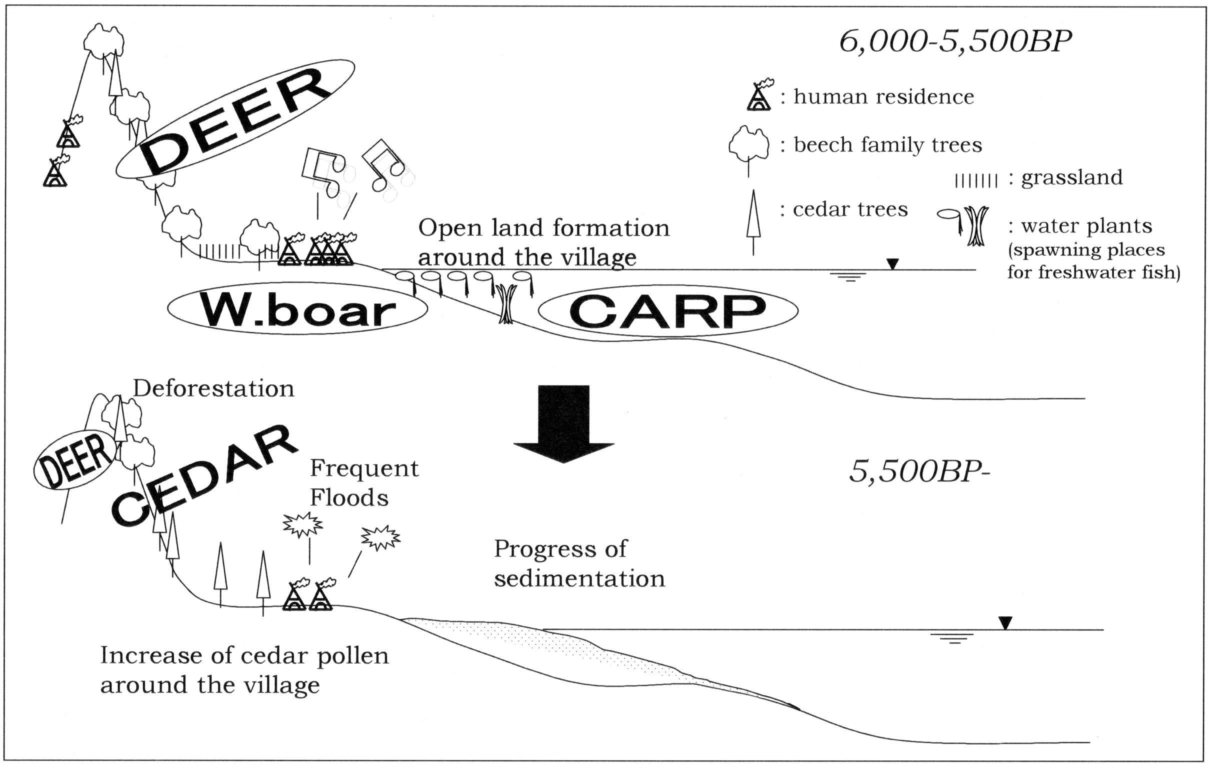

6,000-5,500BP
: human residence
: beech family trees
: grassland
: cedar trees
: water plants (spawning places for freshwater fish)
DEER
W.boar
CARP
Open land formation around the village
Deforestation
DEER
CEDAR
Frequent Floods
5,500BP-
Progress of sedimentation
Increase of cedar pollen around the village

Fig. 30. Depiction of deforestation as the cause of the abandonment of Torihama shellmidden.

9th ICAZ Conference, Durham 2002
Beyond Affluent Foragers (eds Colin Grier, Jangsuk Kim and Junzo Uchiyama) pp. 168–191

12. Resource Patch Sharing Among Foragers: Lack of Territoriality or Strategic Choice?

Jangsuk Kim

In this paper social aspects of logistical mobility and their implications for understanding territoriality amongst hunter-gatherers are considered. Although Binford's model of hunter-gatherer land use strategies has contributed much to archaeology, it does not address or explain the dynamics of socioeconomic competition among groups competing for the same resource patches within a region. Examination of central-western Korean Chulmun hunter-gatherer land use strategies suggests that access to resource patches was open to various hunter-gatherer groups present in the region. An absence of strong territoriality and the sharing of access rights to resource patches is here argued to have been a strategy chosen among various possible options for addressing resource patch conflicts. This strategy was economically less expensive and socially less risky than sharing of already-procured resources. Thus, a lack of territoriality cannot be used to argue that late Chulmun groups lacked "complexity".

Introduction

The relationship between hunter-gatherer behaviour and the environments they inhabit has been a major concern in archaeology. In conceptualizing this relationship, many archaeologists have viewed hunter-gatherer behaviour as strictly a means of adaptation to the external environment. The term "Affluent Foragers" has been based in large part on this perspective, advancing that characteristics such as a high degree of sedentism, high population densities, intensive exploitation of resources, and relatively complex social systems were adaptive tools developed to effectively subsist in affluent environments. Although usually more nuanced than simple environmental determinism, such a perspective sees the environment as the single most important contributor to the development of the characteristics that distinguish "Affluent Foragers" from those in non-affluent environments (Koyama and Thomas 1981; Koyama, this volume).

Recent research, however, reveals that hunter-gatherer behaviour is not simply a product of adaptations to specific natural environments but also must be seen as elements of sociopolitical strategies. Moreover, hunter-gatherer behaviours and sociopolitical strategies can be quite varied within the same environmental setting. In other words, although a general relationship between the natural environment and human behaviour does exist, there is no one-to-one connection between them, and human-human relationships are another critical factor affecting hunter-gatherer behaviour (Casimir and Rao 1992; Kelly 1995; Kim 2003). For example, sharing among and within hunter-gatherer groups can be seen not only as an adaptive behaviour to increase fitness of individuals and groups but also sometimes as an intentional strategy of donors to create debt-relationship, which can produce social inequality in the long run (e.g., Gosden 1989). Mobility, which has been typically viewed as an adaptational strategy that evens out spatial resource variability, can also be viewed as a social strategy aiming at accessing regional information and maintaining sociopolitical networks (Kelly 1992, 1995). These recent notions identify hunter-gatherer behaviours as not simply responses to the natural environment but also as strategic choices amongst a variety of feasible options in which intersocietal relations are critical variables.

The diverse and complex relationship among subsistence, environment and sociopolitical strategising has thus become an important topic in archaeology. In relation to hunter-gatherers, however, sociopolitical and adaptational aspects of behaviour still tend to be studied separately. In this article, I focus on the relationship between sharing and the land-use strategies of hunter-gatherers during the central-western Korean late Chulmun Period (3500–1300 BC). Traditionally, sharing behaviour and land use strategies have been regarded as different realms of research: sharing behaviour has been viewed as based on negotiations among individuals and among groups, that is, interagent behaviour, while hunter-gatherer land use strategies have been considered a means of adaptation to the environment adopted by each agent, that is, a microeconomic behaviour. In this paper, I suggest that these two behaviours that appear to exist at two different scales are actually closely related. In so doing, I argue that the lack of territoriality evident in late Chulmun Period Korea was a form of sharing behaviour strategically chosen by and negotiated among hunter-gatherer groups. I propose and test a model for this behaviour based on the analysis of ceramic assemblages from the region.

Binford's Model of Hunter-Gatherer Land Use Strategy

Various arguments have been proposed regarding the diversity and multidimensionality of hunter-gatherer land use strategies but many of these positions are based on ethnographic observations rather than archaeological data. This is in large part because it is difficult to document patterns of mobility from archaeological data alone. Binford's heuristic dichotomy of hunter-gatherer mobility (1980) is an attempt to circumvent this problem by establishing middle range theory that links hunter-gatherer land use strategies to their archaeological consequences. As is well known, he divides hunter-gatherer mobility into residential mobility and logistical mobility. In residential mobility organisation, also called the "mapping-on" strategy, hunter-gatherers, the consumers, move to food resources and residential moves are scheduled to correspond with the availability of resources. In logistical organisation resources are moved to consumers via task groups; storage facilities at residential bases are used much more intensively.

This division does not fully explain the diversity of hunter-gatherer mobility – Binford (1980) himself notes that the two are not a dichotomous division but two extremes on a continuum – and many studies have shown that the division between a mapping-on strategy and logistical organisation does not mark only a difference in mobility but is also a useful heuristic tool for understanding broader land use strategies (Chatters 1987; Jochim 2001; Kelly 1995; Thomas 1981). Research also indicates that this archaeologically applicable dichotomy may provide a better insight into the archaeology of prehistoric hunter-gatherers than does the documentation of the diversity of hunter-gatherer mobility by using ethnographic cases as analogies. While I do not deny the importance of ethnographic data in explaining and characterizing the extreme diversity of these strategies, any model should be archaeologically testable.

This is not to say that, despite its archaeological applicability, Binford's model of mobility is the best choice we can have. To develop a more thorough understanding of hunter-gatherer land use strategies, we must refine and expand Binford's model. In order to do so, I examine intergroup aspects of hunter-gatherer mobility. One of the flaws of Binford's model is that it assumes that only one group exploits any area independently. What would happen if two or more groups coexist in an area, in pursuit of the same resources and patches? In such cases, competition, conflicts, or negotiation between groups for accessing resources would be expected and these factors would significantly affect hunter-gatherer mobility strategies. This means that a land use strategy is not only an economic, ecological behaviour but also a social behaviour critically affected by other agents and their actions. To expand upon this view, I propose and test heuristic models for the social aspects of hunter-gatherer land use strategies by examining the logistical mobility of central-western Korean late Chulmun hunter-gatherers.

The Late Chulmun Period of Central-western Korea

A Brief Introduction to central-western Korean late Chulmun (3500–1300 BC)

The Chulmun Period of central-western Korea began around 5000 BC (Han 1978, 1983; Im 1983b, 1983c, 1984; Kim 1986). It is divided chronologically into the Early Chulmun (EC: 5000–3500 BC) and Late Chulmun (LC: 3500–1300 BC) (Kim and Yang 2001). Like Japanese Jomon hunter-gatherers, Korean Chulmun hunter-gatherers used pottery. With very few exceptions, central-western Korean Chulmun pottery is round bottomed and decorated with various geometric comb patterns. Except for grinding stones such as mortars and pestles, stone tools are chipped, and include points, axes, and net sinkers.

The subsistence economy of the central-western Korean LC depended heavily on hunting, fishing and gathering, although there was extreme regional diversity in the subsistence economy (Lim 1998, 2001a). Freshwater fishing and collection of plant resources were a major part of the LC subsistence economy, evident in the hundreds of net sinkers and acorns, nuts, and wild millets found in residential base site. At a few residential bases the cultivation of millets may have been practiced, although dependence on this food seems to have been extremely low (Ahn 1996; Lee 2001). The exploitation of sea resources was also an important part of subsistence. Shell middens are present on hundreds of small inshore islands in the Korean West Sea (Yellow Sea); most of these islands are smaller than three square kilometres. There is wide consensus among northeast Asian archaeologists that the LC subsistence economy was based on a broad spectrum foraging economy (Ahn 1993, 1996, 1997; An 1991; G. Lee 1991, 1995; J. Lee 2001; Shin 1994). Plant cultivation played, if any, very limited role and was aimed only to broaden the subsistence spectrum (Aikens 1992; Aikens and Rhee 1992; An 1991; Ahn 1991, 1996; Kim 2003; Lee 2001).

LC sites are divided into two categories: sites with dwellings and those without dwellings. While the former have substantial houses and storage pits, the latter contain only remnants of temporary shelters, open-air hearths, or ceramic scatters. It is widely considered that LC foragers practiced logistical mobility with a low degree of residential mobility (see below; Kim 2002; Lee 2001; Lim 1998).

Logistical Mobility and Site Classification: A Methodological Consideration

Binford's (1980) concept of logistical mobility posits the highly structured use of a diverse landscape by a hunter-gatherer group. When two or more types of contemporaneous sites exist with clearly different archaeological features that indicate different activities took place at each, this provides an indication that the group was logistically organised. Therefore, to understand the logistical organisation of hunter-gatherers, examination of the variability among sites is key. A common approach to understanding intersite variability involves erecting conceptual categories of site function in the settlement organisation (Jochim 2001). Sites tend to be dichotomised into two categories, residential bases and limited activity stations (or field camps). There would be, of course, a variety of sites with distinct functions and this dichotomy may be insufficient in explaining the intersite variability of hunter-gatherers. For example, Bamforth (1991) distinguishes hunter-gatherer sites in the Santa Ynez Valley, California as seasonal residential bases, short-term camps, and limited use sites. Other types of sites known from various ethnographic and archaeological records include locations, extraction sites, kill sites, aggregation sites, processing sites, caches, transitory sites, snacking camps, all of which have to somehow be distinguished archaeologically (e.g., Bang-Andersen 1996; Gamble 1991; Meehan 1983). The definition of these sites is, however, context specific. They typically show low archaeological visibility, and are therefore often lumped into the category "limited activity stations". In many areas, the dichotomisation of hunter-gatherer sites into residential bases and limited activity stations has proven to be a more viable starting point for understanding the intersite variability of hunter-gatherers (Habu 1996; Jochim 2001).

It is never an easy task to distinguish archaeologically between residential bases and limited activity stations or to identify the functions of each limited activity station. Yet, despite these difficulties, comparison between sites may enable us minimally to distinguish residential bases and limited activity stations. In this dichotomisation of site functions, two assumptions may be made about site characteristics: (1) they also will be dichotomous or bimodal and (2) they will co-vary in a patterned manner (Bamforth 1991; Binford 1982; Chatters 1987; Davidson 1983; Fisher and Strickland 1991; Jochim 2001; Shott 1986; Thomas 1981). Essentially, the organisation of settlements is assumed to structure (or, be structured by) the organisation of activity intensity and diversity, the organisation of artefact manufacturing, and the organisation of food resource exploitation and transportation.

Due to behavioural and environmental variability and the complexity of hunter-gatherer logistical organisation, classificatory characteristics used by archaeologists to divide residential sites and limited activity stations vary with context, according to factors such as the nature and degree of logistical mobility, availability of resources and their distribution, the nature of the subsistence economy, and the availability of archaeological data in a given situation. Among the important elements are:

a. Site size and duration (residential sites > limited activity stations)
b. Assemblage diversity (residential sites > limited activity stations)
c. Resource diversity (residential sites > limited activity stations)
d. Relative rarity/abundance of substantial structure and storage (abundant in residential sites and rare in limited activity stations)
e. Relative rarity/abundance of non-portable, heavy items (abundant in residential sites and rare in limited activity stations)
f. Relative rarity/abundance of evidence of manufacturing (abundant in residential sites and rare in limited activity stations)
g. Relative rarity/abundance of non-subsistence activities (abundant in residential sites and rare in limited activity stations)

In general, residential bases are thought to have been relatively large, containing evidence for more substantial occupation such as houses and storage, for a greater diversity of activities and resources and for artefact manufacturing, and sometimes serving as the locus of ritual and social interaction. Limited activity stations, by contrast, are expected to be smaller and more specialized in both activities and resources, with little evidence of artefact manufacturing but considerable evidence of non-local materials brought in, and to have few non-subsistence activities.

Confusing this dichotomy is variation along another dimension – seasonality. Residential bases of different seasons can vary in some of these same characteristics due to changing resource opportunities and fission/fusion processes (Bailey 1983; Bailey et al. 1983; Monks 1984; Rocek 1988; Yesner 1994). But even small residential bases occupied in seasons when few resources are available are assumed to be substantially different from limited activity stations by virtue of their organisational status as residential bases (Jochim 2001). They still should be more diverse in activities, including those not directly related to subsistence.

Other confusing processes include reoccupation and temporal changes in site function. If this entails functional redundancy (a hunting camp is always a hunting camp), then size and duration will be most affected, with limited activity stations appearing quite large and rich but still relatively specialized. If, on the other hand, sites are reused in different ways, then diversity of contents should increase, blurring the division between site types (Bamforth 1991). Whether return is anticipated or not (Kent 1992, 1993) is another factor affecting the site characteristics, although this aspect usually concerns residential mobility strategies rather than logistical mobility.

Despite these problems, the conceptual categories of residential bases and limited activity stations are commonly used and have proven useful. Of course researchers should always ensure that this dichotomy, imposed upon the archaeological record, not obscure the real behavioural variability and organisational principles underlying the archaeological record (Jochim 2001).

The Central-Western Korean Late Chulmun Site Classification

Some of the criteria proposed above seem to clearly distinguish residential bases and limited activity stations of the central-western Korean LC. One of the most critical criteria that distinguish the two types is the relative degree of substantial occupation evidence as measured by the relative rarity/abundance of substantial structures and storage.

Residential Sites

Although the number is not great (n = 12), some LC sites in major river valleys and along the region's west coast have characteristics typical of residential sites. At Amsadong settlement (Im 1985; National Museum of Korea in Seoul 1995, 1999), the largest Chulmun site located in the Han River Valley, 28 round pit houses and hundreds of storage pits have been identified. At this site, vast amounts of ceramics, heavy stone mortars and pestles, and evidence for the production of stone tools and ceramics have been found. The dwellings and storage pits show relatively substantial year-round occupation. This suggests that at this site some degree of substantial everyday activity took place and thus it was a permanently occupied residential site.

Hundreds of chestnuts (*Castanaea crenata*), acorns (*Quercus acutissima*), walnuts (*Juglans sinensis*), wild millet remains (*Echinochloa crus-galli, Panicum miliaceum*, or *Andropogon sorghum*) and other plant remains have been recovered from the dwellings and storage pits. Judging from the large number of stone net-sinkers, these people appear to have actively exploited freshwater resources from the Han River. It is not clear whether hunted animals played an important role in their subsistence economy, because no bone remains have been found due to the poor preservation conditions. However, it seems reasonable to assume that along with collecting botanical resources, a certain degree of animal hunting was practiced, judging from many chipped stone points from the site.

Although smaller in size than the Amsadong site, other residential sites have been identified in major river valleys and on the west coast. Misari settlement (Im et al. 1994) in the lower Han River Valley revealed the same archaeological features as Amsadong. Naepyong settlement, Chunsong, located in the upper Han River Valley also has a few dwellings and heavy stone tools (Han et al. 1974). Dunsan settlement, Daejon, in central Korea also has several LC dwellings and storage pits (Lee and Pak 1995). Ssangchongri settlement, Chongwon (Shin 1993) and Songjukri settlement, Kumrung (Shin 1989), also revealed several LC dwellings. All of these sites appear to have been residential sites, because of not only the existence of pit dwellings, large number of ceramics, and heavy stone tools (such as mortars), but also evidence for storage and stone tool making. A characteristic of these inland residential sites is that they are located along major and secondary rivers. Along with the existence of many stone net-sinkers in these sites, it indicates that LC people depended heavily on freshwater resources.

Sites considered to have been residential have also been identified on the coast and on large islands in the Korean West Sea. Gwansanri settlement, Boryong, on the west coast of the region has several LC dwellings with various stone tools and many ceramics (Chungnam National University Museum 1994, 1995; Yoon and Lee 1996). Excavation at Nundul settlement in Youngjongdo, one of the largest islands on which terrestrial resources are relatively abundant, revealed a few dwellings, storage pits, and a possible ritual area (Im and Yang 1999).

Without exception, all of these residential sites have storage pits near dwellings. Although it is difficult to determine the degree of residential mobility due to the small number of residential sites found so far, storage facilities strongly suggest that substantial, long-term, if not year-round or permanent, occupation existed at these sites. These archaeological features clearly distinguish these sites from contemporaneous sites lacking evidence for substantial occupation.

Limited Activity Stations

There are many LC sites from which no evidence for substantial, year-round occupation has been found; most of these are shellmiddens extensively distributed along the coast and on islands in the Korean West Sea. In sharp contrast to contemporaneous residential sites that have pit structures such as houses and storage pits, the shellmiddens have only open-air hearths. Excavation of Gado shellmidden (Pak et al. 2001) has revealed several superimposed open-air ground camps. The depth of shell accumulation, ceramic styles, and radiocarbon dates indicate that this shellmidden formed continuously from the beginning to the end of the LC. Yet despite the long duration of this shellmidden, it lacks substantial pit dwellings and storage pits, having only open-air hearths. The occupants flattened the ground and constructed hearths directly on the ground surface. Evidence indicates that camps and hearths were abandoned after temporary occupations and when the same camp was reused, the ground was re-flattened and the hearth was repaired and reused, often in the same spot (Fig. 1). This repeated process of 'temporary occupation – abandonment – reoccupation – repair/rebuild – abandonment' indicates that such sites were regularly but temporarily visited and occupied for limited activities and abandoned shortly after.

Excavation of Oido Shellmidden (Im and Pak 1988) also revealed only hearths on, under, or near shell deposits. As was the case in other shellmiddens, in Oido, no heavy stone tools such as mortars for grinding botanical resources are found and the number of and diversity in stone points is extremely limited. Radiocarbon dates and ceramic styles show that this island was also occupied regularly for a long time, but temporarily, not permanently. What differentiates Oido Shellmidden from Gado is that instead of occupying the same spot and refurbishing existing hearths for re-use, the spot of temporary occupation moved frequently, suggesting that when people revisited the island, different spots were regularly chosen.

Although not many shellmiddens have been excavated, all of those excavated reveal similar patterns of repeated temporary occupation and negative evidence for year-round occupation. Combined with the fact that many small islands (usually smaller than 3 square kilometres) in the Korean West Sea lack fresh water and plant/animal resources, this indicates that only special activities, including shellfish gathering and processing, were conducted at shellmiddens.

Lack of evidence for substantial occupation is also found at coastal shellmiddens such as Konamri (Kim 1983; Kim et al. 1990, 1991, 1993) and Daejukri (An and Lee 2001). Although these coastal shellmiddens sites offered access to fresh water, plant/animal resources were available nearby, and systematic excavations have been carried out for years, they still have revealed no evidence of substantial pit structures or heavy stone tools, having only ceramics and a limited numbers of stone tools. These coastal shellmiddens are considered to have been the LC functional equivalent of those on small islands. Although a systematic investigation of stone tool assemblages from shellmidden sites and comparison with those from sites with substantial structures (i.e., residential sites) is still under way, the diversity of stone tool assemblages from shellmiddens appears to be much lower than at residential sites (Lim 2001b).

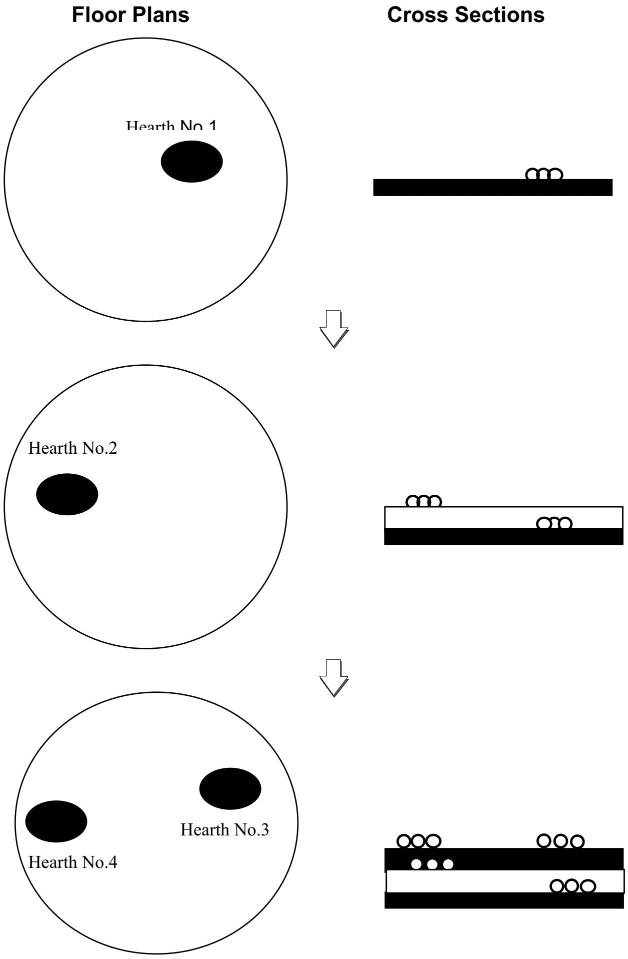


Fig. 1. Field camps and hearths from the Gado Shellmidden (adapted from Pak et al. 2001). Temporary visits repeatedly took place at the same spot. Hearths were abandoned after the task group left, and then reused or rebuilt nearby during the next visit.

Shellmiddens during the LC are the result primarily of the collection of oyster. J. Lee analysed the faunal remains from shellmiddens on small islands, and found that oysters (*Crassostrea gigas*) account for more than 97% of faunal assemblages (98% at the Gado Shellmidden

[Lee 2001] and 97% at the Oido Shellmidden [Lee 1994]) despite many other kinds of shellfish and sea resources having been available around the islands. Extremely limited amounts of animal bones and fish bones available locally were revealed in her analyses. The coastal shellmiddens exhibit the same pattern as shellmiddens on islands. An and Lee (2001) have conducted similar analysis of two coastal shellmiddens where other shellfish, fish and animal/plant resources are easily accessible. This analysis reveals that the Daejukri Shellmidden on the west coast consists of 99% oysters, while it lacks animal and fish bones altogether and has very limited amounts of other kinds of shellfish. Another analysis conducted by D. An (1991) also shows that at Konamri Shellmidden, a coastal site, oysters account for 92.1% of the LC faunal assemblage.

This extreme dominance of oyster at shellmiddens, regardless of their locations, obviously indicates that in LC the target resource for shellmidden access was oyster. That is, the reason for accessing shellmiddens on small islands in the West Sea and on the coast was to collect oysters, not other kinds of shellfishes, fish, or sea mammals, although many other edible sea resources and animal resources were available at these sites, especially at coastal shellmiddens. Comparison of LC shellmiddens with later periods (Middle and Late Mumun: 800–100 BC) demonstrates a clear distinction in resource exploitation strategy between LC and later periods. Konamri shellmidden, which has both LC layers and Middle/Late Mumun layers, reveals distinctively different faunal assemblages when comparing the former and latter. Although oysters dominate both faunal assemblages, the Middle/Late Mumun assemblage contains many kinds of fish and other kinds of shells, while the LC layer has very few fish and animal bones (Figs 2, 3 and 4). The same change in faunal assemblage in later Mumun assemblages is also evident in other shellmiddens such as Oido and Gado.

Sites that lack evidence of substantial occupation are not limited to shellmiddens. Isolated hearths on the sand beaches of small islands have been found at Sammokdo and Yongyudo, without associated shellmiddens, stone tools or structures (although some ceramics were recovered). Byolmang site, a coastal site in Ansan, has only scatters of ceramics and open-air hearths without any evidence for permanent occupation (Kim 1979). Lipid acid analysis of soils from hearths at these sites suggests that these non-shellmidden camps were sea fishing and fish processing stations (Yoo and Yoon, 2003).

Undoubtedly there were more limited activity stations in the region, especially on areas inland. Due to the low visibility of inland sites in contrast to shellmiddens, their distribution has not been convincingly documented. Nevertheless, the distribution of known LC sites suggests that many inland sites may have been limited activity stations. The number of LC sites that have been reported through either excavation or site survey is as many as 170 throughout the region, among which approximately 80 are shellmiddens on the coast or small islands in the Korean West Sea, while around 90 are inland sites. Excavations have been conducted at 37 of the 90 inland sites in the region. Most of them failed to discover dwellings or evidence for substantial occupation, but instead only revealed LC ceramic fragments, as was the case at the Byolmang site.

Dwellings or substantial structures have been found at only twelve sites, all of which are considered residential bases as discussed in the previous section. The number of stone tools and ceramic sherds found at sites lacking substantial structures is extremely limited, while many ceramic sherds and stone tools were recovered from those with dwellings. This fact – that only 12 LC sites have evidence for substantial occupation and the approximately 90 inland sites are only scatters – suggests that many LC sites were limited activity stations. It is possible that later occupation destroyed the LC dwellings and thus they are invisible. However, since scatter sites are dominant in number and many of them are located in places where no later occupations were detected, most ceramic scatters were probably limited activity stations, although we do not have a clear idea of what activities took place at these sites. Because the number of sherds from these inland sites is unfortunately very small (usually n < 20), I do not include them in the following analysis and the reconstruction of LC logistical mobility will be mainly concerned with sites on islands and along coasts. Despite limitations of the data, LC sites of Central-western Korea can minimally be divided into residential sites and special activity stations, of which the latter in turn can be subdivided into shellmiddens and non-shellmidden limited activity stations. Since all of these sites are generally contemporaneous, differences in site function indicate that LC foragers adopted logistical organisation in which various different resource patches were exploited.

Logistical Mobility, Territoriality and Resource Patch Sharing

Studies of hunter-gatherer land use strategies have been concerned with the relationships between (1) populations and environmental factors such as spatial distribution and temporal variability of resources (Binford 1980, 1982, 1983; Fletcher 1991; Heffley 1981; Kaplan and Hill 1992; Kelly 1983; Thomas 1983; Whitelaw 1991), (2) mobility, technological organisation and/or its spatial structure (Binford 1983; Bamforth 1991; Chatters 1987; Hitchcock 1987; Kent 1991; Nelson 1991; Nicholson 1991; Shott 1986, 1996; Yellen 1977), and (3) mobility, intrasocietal labour organisation and task group composition (Binford 1991; Eder 1984; Whitelaw 1991; Yellen 1976, 1977). In these studies, which Gamble (1991) calls the “ecological framework”, mobility is often seen as a means

Species	LC	MM/LM	Habitat
Crassostrea gigas	*	*	intertidal
Cyclina sinensis	*	*	intertidal
Gomphina veneriformis		*	intertidal
Mactra veneriformis		*	intertidal
Meretrix lamarcki		*	intertidal
Mya arenaria oonogai		*	intertidal
Sinnovacula constricta		*	intertidal
Tapes philippinarum	*	*	intertidal
Notochione jedoensis	*	*	intertidal
Mytilus coruscus		*	from intertidal to shallow water
Tegillarca granosa		*	from intertidal to shallow water
Atrina pectinata japonica		*	shallow water
Chlamys farreri		*	shallow water
Ostrea denselamellosa		*	shallow water
Scapharca broughtonii		*	shallow water

Fig. 2. Marine bivalves recovered from the Konamri Shellmidden and their typical habitats (LC=Late Chulmun; MM=Middle Mumun; LM=Late Mumun). Data from D. An (1991).

Species	LC	MM/LM
Sus scorfa		*
Cervus nippon	*	*
Moschus moschiferus prvipes		*
Eumetopias jubata		*
Canidae		*
Canis familiaris		*
Nyctereutes procyonoiddes		*
Vulpes vulpes peculiosa		*
Felidae		*
Felis bengalensis		*
Meles meles		*
Rattus sp.		*

Fig. 3. List of identified mammal species from the Konamri Shellmidden (LC=Late Chulmun; MM=Middle Mumun; LM=Late Mumun). Data from D. An (1991).

Species	LC	MM/LM
Chrisophrys major		*
Achanthropagurs schlegeli		*
Argyrops bleekeri		*
Branchiostegus japonicus		*
Bothidae		*
Rajiformes		*
Paralichthys olivceus		*
Holorhinus tobijei		*
Squalidae		*
Triakidae		*
Tetraonontidae		*
Fugu pardalis		*
Sphoeroides rubripes		*
Platycephalus indicus		*
Nibea imbricata		*
Ilisha elongata		*
Agyrosomus argentatus		*
Astroconger myriaster		*
Sardinia melanosticta		*
Engraulis japonica		*
Mugil cephalus		*
Salmonidae		*
Chelidonichthy kumu		*
Seriola quinqueradiata		*

Fig. 4. List of identified fish species recovered from Konamri Shellmidden (LC=Late Chulmun; MM=Middle Mumun; LM=Late Mumun). Data from D. An 1991.

of "averaging over" variability in the spatial and temporal distribution of resources. That is, mobility is understood as a microeconomic and ecological behaviour to adapt to the natural environmental structure, through which people optimally react to environmental variability using their technology and social organisational structure. Therefore, researchers have focused on how mobility is practiced at an individual (group) level. Binford's (1980) model of residential mobility and logistical mobility is mainly concerned with this aspect of mobility.

However, despite the microeconomic/ecological approach's contributions to understanding hunter-gatherer mobility and labour organisation, it is often of limited use in explaining hunter-gatherer land use strategies on a larger scale, in that models based on this approach assume that only one group occupies an area, independently and optimally reacting to environmental variability and exploiting various local patches. This approach leaves a few questions unanswered. What happens when two or more groups coexist in a region, competing for the same resources? Would they still use land independently and optimally? If multiple mobility units (or subsistence economic units) coexist in an area, competition over the same resources may occur and intersocietal aspects such as interaction, negotiation, or conflicts between competing units would critically affect the regional macro- and political economy and consequently the land use strategy of each unit.

Many recent discussions of hunter-gatherer mobility have been concerned with social aspects of mobility, emphasizing that mobility is not only a strategy that ameliorates the effects of spatial/temporal environmental variability, but is also important in maintaining social networks and collecting information (Casimir and Rao 1992; Gamble 1991; Kelly 1992, 1995; Smith 1981; Wiessner 1982). This approach, the "social framework" in Gamble's (1991) term, considers mobility as not merely a matter of human-environment relationships but also that of human-human relationships. Unfortunately, despite some useful insights, works are primarily based on ethnographic observations of contemporary hunter-gatherers and archaeological applications are few.

Intergroup competition and its impact on hunter-gatherer mobility and land-use strategies have rarely been a major concern in archaeological studies of recent prehistoric hunter-gatherers. However, the relationship between competition and mobility has been studied with regard to early hominid behaviour, providing some important contributions despite some differences in context. Brantingham (1998) shows that interspecific competition over carcasses critically affected the mobility strategy of early hominids, especially the organisation of labour and timing of foraging. His study indicates that mobility is not only a strategy for resource procurement but also a situational tactic for responding to other competitors. When applied to prehistoric hunter-gatherers, this discussion strongly suggests that competition between groups competing over the same resources could also be a critical factor in hunter-gatherer mobility patterns. Yet, there are some points of comparability to consider. First, while hominid competition with carnivores over carcasses is competition over movable resources, competition between human groups over land is competition over immovable, fixed location resources. Thus, the subject of competition (i.e., land) remains there all the time, unlike carcasses. Second, the competition between hunter-gatherer groups can be negotiated, or, in some cases, can become an enduring conflict with other competitors. Because of these two points, competition between hunter-gatherer groups over land is much more complex than competition between species over carcasses, on the one hand, and on the other is much more predictable and patterned, and affected less by situational factors.

If so, how could we characterise the relationship between competition and hunter-gatherer land use strategies under conditions of logistical mobility? If there are resource patches that are more productive or more reliably provide resources than other patches and if each hunting-gathering is aware of this, then each group will try to access those resource patches. When many groups in the region try to exploit such resource patches, either social competition/conflict or negotiation between the groups takes place. Possible outcomes may include the exclusion of other groups from certain patches by a specific group (interference competition in ecological terms; Yodzis 1978) or sharing of those patches with other competitors, accepting the reduced resource returns (exploitation competition in ecological terms). No matter which is the case, as long as two or more groups coexist in a region competing over the same resources, actions and reactions between competitors will critically affect the pattern of logistical mobility, especially the range and intensity of resource exploitation and consequently the spatial distribution of archaeological remains and archaeological assemblage formation.

One of the most important social factors that affects the range and intensity of logistical mobility is territoriality. The concept of territoriality assumes that two or more groups coexist in an area because if there is only one group in the region there is no reason to develop territoriality. Many discussions of territoriality tend to focus on the conditions under which it develops. Anthropologists and archaeologists have pointed out that in general territoriality will be developed when an important resource is spatially concentrated and when return from exclusive access is expected to exceed the cost of defence (e.g., Dyson-Hudson and Smith 1978; Thomas 1981), although the specific form of territoriality varies considerably depending on context. Smith (1988) and Kelly (1995) have termed this type of model the "economic defence (or defensibility) model".

Some ecologically-driven versions of this model consider that specific environmental conditions in large part determine whether land is shared or exclusively owned.

Dyson-Hudson and Smith (1978), for instance, in their influential work view resource density and resource predictability as two critical factors that determine whether and how a group manages territory. In their view, territorial exclusion is expected when resource density and predictability are sufficient to make the benefits of exclusive use outweigh the cost of perimeter defence. In other words, the greater the resource density and the resource predictability in a specific zone, the higher the chances for the emergence of territoriality. Often models stipulate that the packed distribution of various resources is the single most critical factor in determining whether land is shared by multiple groups or exclusively owned by a group (Hickerson 1965; Thomas 1981; Wattrall 1968) because territoriality (or boundary maintenance) has a direct adaptive role in the sense that a protected territory serves as a "reservoir" for accessing resources. Yesner (1985) adds another factor – the existence of a resource-poor zone that acts as an isolating barrier between tightly packed resource-rich zones. In all these models the natural environment dictates the conditions of territoriality.

Territoriality is also often seen as a group decision under specific environmental and social situations. Greatly influenced by economics (especially Demsetz 1967), this approach usually explains territoriality (in relation to private property rights) as the result of the trade-off between the benefits and costs of exclusion of others from the use of the lands (see Colin 1998). In explaining the development of territoriality, this approach focuses on each group's decision-making processes. If benefits from territoriality exceed the costs of maintenance and boundary defence, groups will choose territoriality rather than open access or sharing land with other groups. Population density has been considered the major factor that affects this decision-making process. Feit (1994) and Johnson and Earle (2000) propose that population growth and increased competition create a need to regularize access to resources. As land becomes scarcer and land stress increases in relation to population pressure or due to an increase in the demand for and competition over land and its resources, a system of land tenure tends to develop from an initial situation of open access or common property (Earle 1998, 2000; Johnson and Earle 2000). Under this condition, groups will decide as to whether territoriality is a good choice or not, comparing benefits and costs of claims to land ownership. Set within an evolutionary framework, this approach is often used to explain the evolution of hierarchies or complex society (Johnson and Earle 2000).

The two-pronged approaches of the economic defence model, whether environmental conditions or rational/individual decision-makings are the focus, are complementary. When both are combined, they explain why a group initially develops or chooses territoriality and claims exclusive land ownership, and under what condition territoriality is the more feasible strategy. They assume in common that boundary defence and management of territory require certain costs that vary with the distribution and predictability of resources as well as population density. Thus, evaluation of the productivity of resources around each group's territory with respect to the likely costs for its defence is the most important relationship in the economic defence model. Since the defence cost and economic return in general correlate with environmental factors such as resource density and predictability, territorial exclusion is expected in environments where density and predictability of key resources are high enough to make benefits of exclusive use outweigh the cost of defence (Smith 1988).

As the economic defence model suggests, the adoption and/or development of territoriality is governed to a considerable degree by economic concerns, especially natural environmental factors, that determine the costs of and benefits from territoriality. However, territoriality is not purely economically driven. Social factors are not necessarily less important than economic factors in that the development and adoption of territoriality will have significant social impacts on other groups. One group's adoption of territoriality changes the social landscape of the region for other groups in a fundamental manner. If one group asserts territorial rights, other groups lose access to land they had formerly available for resource acquisition. An important flaw of current discussions of territoriality is that they look at territoriality only from the perspective of adopters. By so doing, they rarely consider what might happen overall to the regional social landscape if one group claims exclusive land ownership. In an area where a specific patch provides important resources more reliably than others, and if a group claims exclusive access to this patch and prohibits competing groups from using it, the other groups are forced to rely on less reliable patches. The other groups' ranges of both residential mobility and logistical mobility should decrease and the intensity of exploitation of the remaining resource patches should increase. Groups that lose a resource patch could experience difficulties in maintaining a subsistence economy. This in turn could lead to intergroup conflicts. The more productive the lost resource patches and the more critical the resources they provided, the more severe the economic damage to the groups that lost patches.

In such cases, it is expected that groups that lost resource patches to a group that claimed territorial rights to those patches might, as a reaction, prohibit that group from accessing remaining resource patches (Fig. 5 and 6). Claiming exclusive ownership of specific resource patches would mean that the group would be forced to relinquish access rights to other resource patches. In this regard, territoriality is a risk-incurring strategy that imposes socioeconomic costs. Even if foraging groups expect more economic benefits from exclusive rights to specific productive resource patches and can maintain constant exclusive access to these patches by claiming

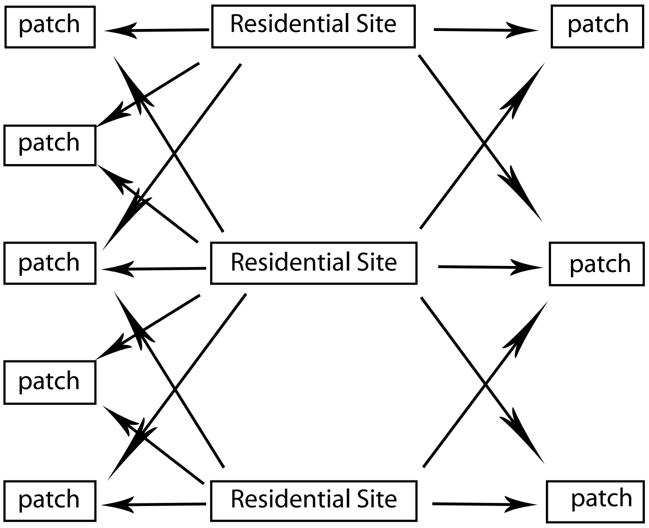


Fig. 5. A schematic model for resource-patch sharing under conditions of logistical mobility.

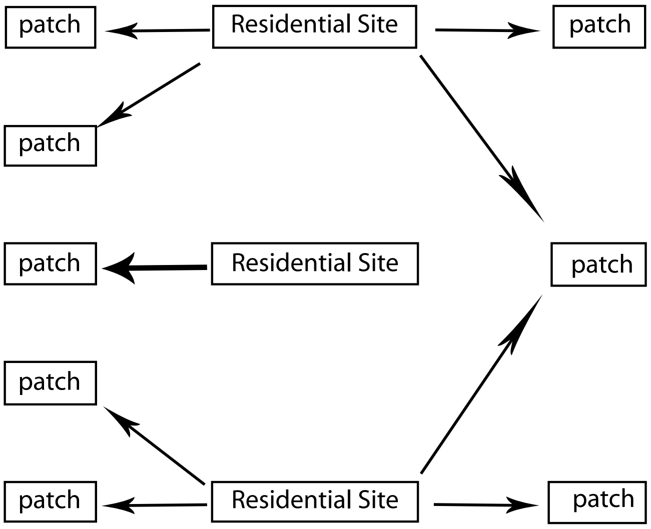


Fig. 6. Patterns of access to resource patches when a group claims exclusive use-rights to the most productive patch. The group that accesses a resource patch exclusively can only access that patch. Other groups in the region would be expected to intensify exploitation of remaining patches as a result.

land, they will typically not claim land ownership unless economic benefits well exceed the cost of social conflicts and of the loss of other patches. This is particularly crucial in the case of a broad-spectrum economy based on targeted logistical organisation and guaranteed access to a variety of patches (including many lower return backup patches to ward against possible resource depletion or failure). If one group is able to access only one patch by claiming exclusive rights to it – even if it may be the most productive one – that group's subsistence economy could face serious problems.

Therefore, in mobile hunter-gatherer contexts, ownership of specific resource patches is a costly and risky strategy both economically and socially. Unless a group urgently needs to exclusively exploit specific resource patches, the group will not assume the cost of defence and the social risks resulting from a claim of exclusive rights to those patches. Instead, the resource patches will be shared with other foraging groups, in different ways and to varying extents (Fowler 1982; Kelly 1995). Unless some group's use of specific resource patches is so intense that it threatens other group's exploitation of those patches (e.g., causes resource depletion), it is unnecessary to claim exclusive rights. By sharing resource patches, each group can access various resource patches according to its needs, and thus can access a wider range of resources in order to avoid resource depletion and seasonal/yearly variations. Examining the ranges of resource exploitation of the Ainu in Hokkaido, Japan in the 1920s, Watanabe (1972, 1983, 1986) showed that various groups could access various resource patches on the basis of resource patch sharing. He demonstrated that although there is some degree of territoriality among Ainu groups around each residential base, many resource patches are shared. By so doing, each group can access various kinds of patches whenever the need arises. Therefore, when various foraging groups searching for common resources coexist in a region, the logistical organisation of resource exploitation may require a certain degree of social negotiation with competitors in order to share resource patches (Burch 1988, 1994; Thomas 1981). Even if there is no formal contract or negotiation between the potential users of specific resource patches, certain degrees of tolerance or grants may be necessary. In this respect, "when options are limited, people will be more careful about their spatial behaviour (Gamble 1991, 10; Whitelaw 1991, 281)".

This is not to say that hunter-gatherer groups that employ logistical organisation always share all resource patches with other groups. If patches that provide the same resources are abundant and are located near each group's residential sites, it is possible that each group more or less exclusively uses these patches. If patches near the residential base consistently provide each group with sufficient resources, they do not need to access other resource patches far from the residential base, in part because of the cost of travelling and transporting resources. From an economic perspective, using distant resource patches is a more expensive strategy than exclusive patch ownership. Under such conditions the exploitation range of specific resources will not be large. Whether or not the rights to patches near residential sites are officially claimed, there may arise some degree of implicit territoriality. Binford (1982) terms this type of territory the "annual range", which refers to areas regularly accessed during an annual seasonal cycle, avoiding the term "territory", which implicitly involves cultural meanings. Whether or not cultural meaning is involved in this type of territory or annual range, however, if a group attempts to access resource patches near other groups' residential bases, some defensive behaviours may occur.

In these respects, any group's land use strategy is not simply an economic strategy decided upon by that group for itself, but also represents (1) a strategic economic reaction to resource distribution and (2) a social reaction to other groups' land use strategies. Therefore, in understanding the land use strategy of LC hunter-gatherers, it is extremely important to look at whether or not resource patches were shared. I turn to this topic below.

A Test of Late Chulmun Land Use Strategy and Resource Patch Sharing

While many discussions of hunter-gatherer mobility and resource patch sharing are based on ethnographies, few attempts have been made to archaeologically document logistical mobility and hunter-gatherer territoriality. In large part this is because it is relatively difficult to connect residential sites and limited activity stations occupied and exploited by the same group. This difficulty in part led to the so-called "Mousterian debate" between Binford (1973) and Bordes (Bordes and Bordes 1970), in which the main issue was whether different assemblages had been produced by different groups with different traditions or resulted from different uses of sites by the same group. How (and whether) various groups share the same resource patches is a difficult question for hunter-gatherer archaeology, which mainly deals with stone tools. In many archaeological studies, intergroup relations vis-à-vis resources have often been inferred rather than tested (for exception see Roth 2000 and Shackely 1996; also see Clark 1989 for an effort to test the connection between hunter-gatherer groups and stone tool assemblages using northern Spain upper Paleolithic and Mesolithic site distributions). The central-western Korean Chulmun case, however, provides an excellent opportunity to archaeologically document these aspects of hunter-gatherer mobility because a variety of styles of pottery were used in hunter-gatherer contexts.

To characterize Central-western LC logistical mobility and sharing of resource patches, I assume that, if small islands in the Korean West Sea were temporarily occupied in order for LC groups to exploit them logistically, then the ceramics from small island sites must have been transported from residential sites. It would have been extremely difficult to acquire clay, tempers, and firewood on these small islands. In fact, no evidence for pottery manufacturing on the small islands has been found. Also, since pottery would have been generally used in residential sites for cooking and storage, it is unreasonable to infer that pottery was manufactured at limited activity stations such as shellmiddens and transported to residential sites without significant evidence for this. Based on this premise, I analyse stylistic diversity in ceramic assemblages from residential sites and limited activity stations on islands to determine whether or not a group exploited one or multiple islands, and whether multiple groups shared exploitation of resources on the same small islands.

Hypotheses and Methodological Considerations

It has been hypothesized that in logistically organized groups assemblages from residential sites are usually more diverse than are those from limited activity stations because activities at residential sites are more diverse and/or occupation length is longer (Bamforth 1991; Chatters 1987; Jochim 2001). This prediction has been supported by a number of studies of stone tool assemblages. For hunter-gatherers using ceramics, the ceramic assemblage would also show similar patterns, especially in terms of vessel function.

As for ceramic decoration rather than functional form, the difference between assemblages from residential sites and limited activity stations will be less obvious. If we assume that ceramics found at limited activity stations were typically not produced there but brought from residential sites, the stylistic diversity in ceramic assemblages from limited activity stations should *not* be greater than that from residential sites in principle, unless ceramic decoration reflect vessel function. Since the size of the residential site assemblage tends to be larger than that from limited activity stations, the diversity indices (especially richness) of assemblages from residential sites will be larger in terms of ceramic decoration, but this would be simply a function of the so-called sample-size effect (Cowgill 1989; Jones and Leonard 1989; Kintigh 1989). Accordingly, when resource patches are not shared but exclusively accessed by one group, it is expected that in general the stylistic diversity in ceramic assemblages from limited activity stations will not be greater than that from residential sites.

This relationship may not be the case, however, if foraging groups shared resource patches. If each group made ceramics with different decoration and if various groups shared use rights to resource patches, then the ceramic assemblages from sites within resource patches (limited activity sites) would consist of styles of ceramics belonging to various groups. Because various groups produced distinctly decorated ceramics, then ceramic assemblages from these sites would in this case be more diverse than assemblages from any residential site. Thus the measures of diversity from limited activity sites could be correspondingly greater despite their smaller sample sizes.

This discussion leads to two alternative hypotheses and corresponding test implications (Fig. 7 and 8):

(1) If each LC group exclusively exploited specific resource patches, the diversity and variation of ceramic decorations from residential sites and their resource patches should not differ. If the sample size of assemblages from patches is much smaller than that from residential sites, the diversity of the latter will be greater (Fig. 7).

(2) If various groups shared resource patches, the stylistic diversity in ceramic assemblages from resource patches should be higher than that from residential sites, indicating that ceramic assemblages from resource patches consisted of ceramics from distinct stylistic traditions (Fig 8).

A necessary condition for these hypotheses is that each group made ceramics stylistically different enough to be distinguished. If ceramic assemblages from residential sites are sufficiently distinguishable, allowing specific types occurring at resource locations to be linked to specific ceramic decorations from individual residential sites, then these hypotheses can be tested effectively. Therefore, I begin by measuring diversity and variation in ceramic assemblages from both residential sites and small island sites, and compare the results.

Analysis

Central-western Korean LC vessels are round-bottomed and have, with very few exceptions, various geometric designs. With the goal of detecting possible intergroup and within-group variation in ceramic decorations, I classify LC pottery decorations into 32 sub-styles, according to structure and shape.

Intra- and Inter-Site Variability in Ceramic Assemblage Structure at Residential Sites

In the hypotheses presented above I assumed that ceramics were produced at residential sites and thus the ceramics found at limited activity stations were not produced there, but were brought to the limited activity stations from residential sites by task groups. If each group produced ceramics stylistically different from other groups, then ceramic style can be used as an indicator in identifying groups. To test this assumption, I look at the stylistic variability of assemblages of each residential site and compare them. If the range of variability within assemblage is not very great, and if the ranges of variation do not overlap, then it is possible to use ceramic decoration as an indicator of that group.

Fig. 9 and 10 show the distribution of each style at LC residential sites at which substantial dwellings were found. Each assemblage consists of one or a few dominant patterns and small amounts of other varieties. For example, at the Amsadong site AIa, AIIb, and AIIIc types are dominant. Three varieties constitute more than 90%. The ranges of variability in herringbone decorations are relatively small in one assemblage and the dominant decorations rarely overlap with other assemblages. Assemblages from other residential sites show the same pattern; a few types are dominant in each assemblage but the dominant ones rarely overlap. This analysis clearly indicates that the assemblage from each residential site has low richness and low evenness, dominated by small number of styles. Therefore, it is possible to see decoration as an indicator of specific residential sites and it is suggested that the each group made different styles of

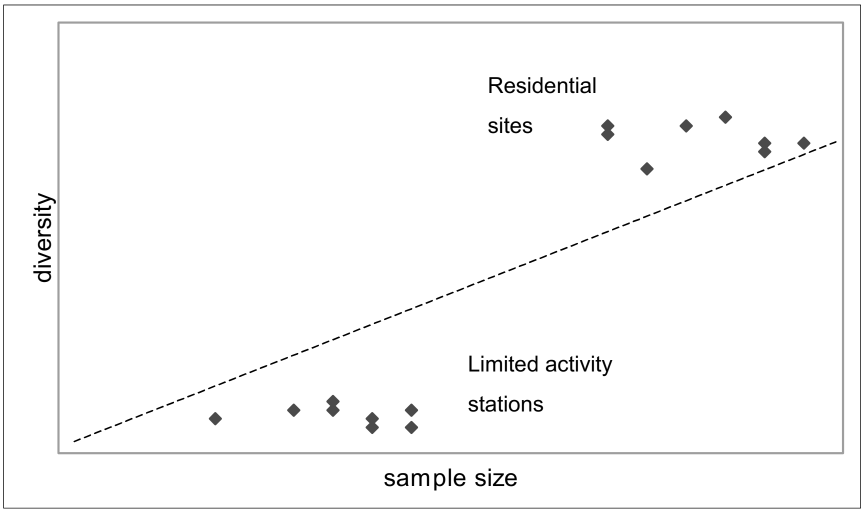


Fig. 7. Expected relationship between site function and ceramic design diversity when each group exclusively accesses their own resource patches.

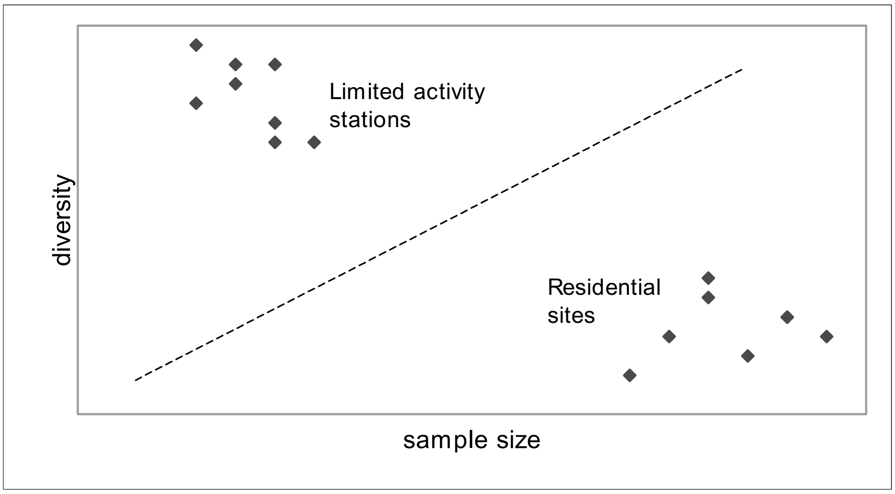


Fig. 8. Expected relationship between site function and ceramic design diversity when groups produce different styles of ceramics and share access rights to patches.

pottery, although there is still some (though minimal) overlap.

The fact that each residential site made stylistically different pottery allows a further suggestion that members of a residential site shared stylistic traditions, although it can never be said that membership in each residential site was strict. Considering that logistical trips, especially access to islands across the sea, are an suprahousehold-level group task conducted by adults, which requires residential group cooperation for procurement and distribution (Binford 1991), I suggest that LC residential sites, consisting of multiple residential groups, comprised a type of socioeconomic unit that planned and organised logistical trips.

Intrasite Variability at Limited Activity Stations

Another implication of the two hypotheses is that the stylistic variability and diversity in assemblages from shellmiddens will be higher than those from residential sites, because they would have been limited activity stations that were shared by various groups. Therefore, each ceramic assemblage from shellmiddens would consist of ceramics brought by various groups from different residential sites. Fig. 11 shows the distribution of each type in assemblages from limited activity stations in which no evidence for substantial occupation is found. Fig. 12 shows that, in sharp contrast to assemblages from residential sites, various ceramic styles coexist in one assemblage and none of them are dominant. Although

design	Nundul	Gwanchang	Gwansan	Amsadong	Hyuamri	Ssangchong	Dunsan
A I a	.75	.00	.00	**20.14**	.00	.00	.00
A I b	2.51	.00	.00	**26.39**	.00	.00	.00
A I c	.00	.00	.00	**34.03**	.00	.00	.00
A I d	.00	.00	.00	3.47	.00	.00	.00
A I e	.00	.00	.00	.00	.00	.00	.00
A II	.00	.00	.00	.00	.00	.00	.00
A III	.00	.00	.00	.00	.00	**10.53**	**10.66**
A IV	.00	1.43	.00	.00	.00	.00	.00
B I	1.76	.00	.00	6.25	.00	.00	.00
B II a i	**82.91**	2.86	.00	1.39	.00	.00	.58
B II a ii	.00	1.43	9.99	1.39	.00	**43.86**	**39.77**
B II a iii	.25	1.43	.00	.00	.00	5.26	1.73
B II a iv	.50	.00	.00	.00	6.67	.00	.00
B II a v	.00	.00	.00	.00	.00	.00	.00
B II a vi	.00	.00	.00	.00	.00	.00	.29
B II b i	.00	**85.71**	5.00	.00	.00	.00	.00
B II b ii	.00	.00	.00	2.08	.00	.00	.29
B II b iii	.50	4.29	.00	.00	**40.00**	.00	.00
B II b iv	.00	.00	.00	.00	6.67	.00	.00
B II b v	.00	.00	**85.00**	.00	**40.00**	.00	.00
B II b vi	.00	.00	.00	.00	.00	.00	.00
B II b vii	.00	.00	.00	.00	3.33	.00	.00
B III a	1.01	.00	.00	.00	.00	.00	.00
B III a ii	.00	.00	.00	.00	.00	.00	.00
B III b i	.00	.00	.00	.00	.00	.00	.00
B III b ii	.00	.00	.00	.00	.00	.00	.00
B IV a	.25	.00	.00	2.08	.00	3.51	.00
B IV a ii	8.79	1.43	.00	1.39	.00	1.75	2.59
B IV a iii	.25	1.43	.00	.00	3.33	.00	.00
B IV a iv	.00	.00	.00	1.39	.00	.00	.00
B IV b I	.50	.00	.00	.00	.00	.00	.29
B IV b ii	.00	.00	.00	.00	.00	.00	.00
C	.00	.00	.00	.00	.00	**28.07**	**41.50**
D	.00	.00	.00	.00	.00	.00	.86
E	.00	.00	.00	.00	.00	7.02	1.44
Total (%)	100	100	100	100	100	100	100
Total counts	*412*	*170*	*79*	*721*	*108*	*157*	*356*

Fig. 9. Relative frequencies (%) of designs in ceramic assemblages from residential sites. Design percents over 10% are bolded.

the sample sizes of many shellmidden assemblages are small, both the richness and evenness of assemblages from these sites are much higher than from residential sites. In other words, in contrast to the general expectation of the sample size effect – that diversity positively correlates with sample size – shellmiddens, despite their lower total counts of ceramic sherds, have much more diverse assemblages than residential sites. This result – that assemblages from residential sites consist of small numbers of dominant decorations which vary with location while those from shellmiddens are much more variable (and not dominated by specific decorations) – clearly indicates that people from various residential bases with distinct ceramic styles visited the shellmidden sites.

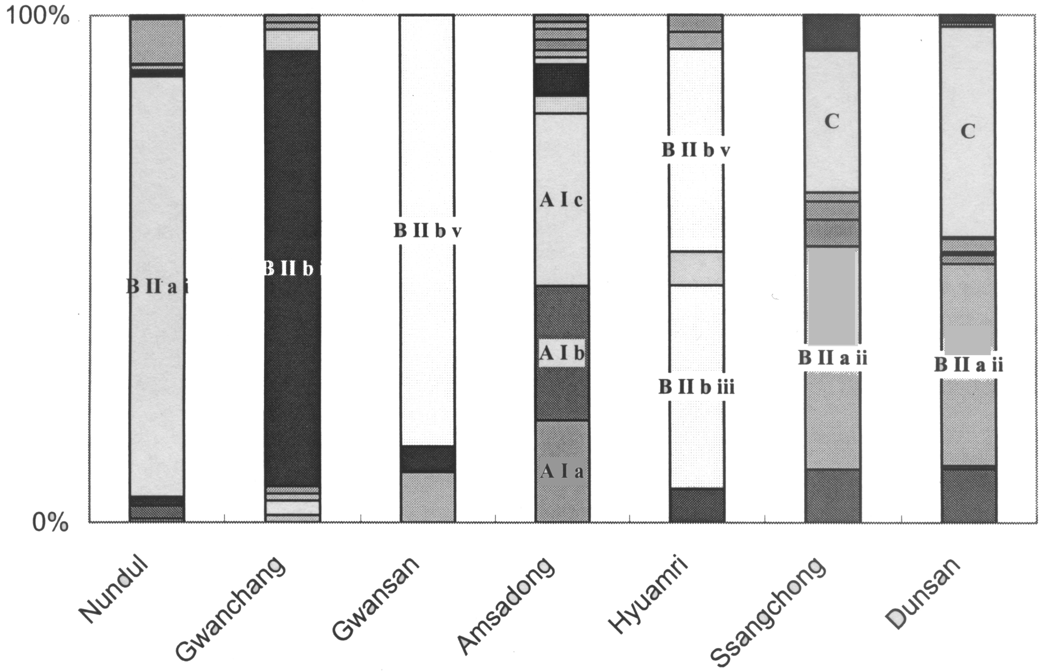


Fig. 10. Summary chart of relative frequencies (%) of designs in ceramic assemblages from residential sites (cf. Fig. 9).

Geographical Distribution of Styles

If certain ceramic decorations and their variations are indicators of LC (residential) groups, then it is possible to infer the range of logistical mobility through the spatial distribution of ceramic styles, although the documentation of full exploitation ranges may not be complete when measured with ceramics alone. In an ideal case not only the exploitation range of each residential group but also the degree of each residential group's dependence on specific resources would be detectable. If we assume that activities conducted at a shared resource patch did not vary with groups and that the amount of ceramic sherds that can be assigned to a specific group correlates with its frequency of visitation, duration of stay, and intensity of activities, then the proportion of each group's style may be a proxy measure of each group's relative dependence on this resource patch. If discernable, this would provide important information regarding whether distance, resource productivity, or other social factors affected the access of each group to specific resource patches. However, this inference is only applicable in the case that *all* the residential sites and resource patches were excavated systematically enough to provide a reliable sample. In Central-western Korea, because many assemblages from shellmiddens are surface collections and also many residential sites on the coast would have disappeared during the continuous large-scale land reclamation that occurred between the 1920s and 1980s, it is difficult to expect this situation. However, the geographical distribution of each style will allow investigation of the degree to which distance affected resource patch choice, whether an LC group visited only one specific island or multiple island, and whether the same target resources were included in each group's exploitation range.

To demonstrate the relationship between distances from residential sites to limited activity stations and the stylistic representation of ceramics, statistical similarities between the assemblages were measured and their correlation with physical distance calculated. The frequencies of ceramics were standardized and the squared Euclidean Distance used to measure the statistical distances between assemblages, which were then compared with physical distance. As shown in Fig.13, although the physical distance by no means directly reflects the degree to which shell middens were accessed by various groups, the correlation coefficients are relatively high (Amsadong: r = 0.83; Nundul: r = 0.88). This indicates that distance was an important, if not determining, factor in the patch choice, although presumably LC groups might still have preferred resource patches that were more productive and consistent and the exploitation of productive patches would have been more frequent than that of less productive patches.

These results show that, although shellmidden ceramic assemblages consist of highly diverse styles, distance was

	Sido	Jangbong	Sammok	Songsan	Gaun	Sinpo	Byol	Jebu	Soyado	Dojok	Wonjong	Konam
A I a	8.16	3.33	2.78	5.41	18.72	1.45	2.38	5.26	.00	.00	.00	.00
A I b	4.08	.00	.00	2.70	36.36	.00	.00	10.53	4.76	8.33	2.17	.40
A I c	6.12	.00	16.67	5.41	9.09	.00	.00	10.53	.00	.00	.00	.00
A I d	.00	.00	.00	.00	13.90	.00	.00	5.26	.00	.00	.00	.40
A I e	2.04	.00	.00	.00	.53	2.90	2.38	.00	.00	.00	.00	.00
A II	2.04	.00	.00	.00	.53	1.45	2.38	.00	.00	.00	2.17	.00
A III	.00	.00	.00	2.70	.53	.00	.00	.00	.00	.00	2.17	.80
A IV	.00	.00	.00	.00	.53	2.90	.00	.00	.00	.00	.00	.00
B I	.00	.00	.00	8.11	1.60	.00	.00	.00	.00	.00	.00	.00
B II a i	18.37	30.00	27.78	5.41	.00	13.04	.00	5.26	28.57	50.00	2.17	2.39
B II a ii	8.16	26.67	.00	24.32	.00	8.70	14.29	5.26	19.05	8.33	2.17	12.35
B II a iii	.00	20.00	2.78	8.11	2.67	2.90	11.90	5.26	.00	.00	4.35	29.48
B II a iv	14.29	13.33	.00	5.41	3.21	17.39	38.10	.00	14.29	16.67	4.35	4.38
B II a v	.00	.00	.00	.00	.00	14.49	2.38	.00	.00	.00	.00	.00
B II a vi	2.04	.00	.00	.00	.00	1.45	.00	.00	.00	.00	8.70	.00
B II b i	.00	.00	5.56	.00	0.53	1.45	2.38	10.53	.00	.00	10.87	2.19
B II b ii	8.16	.00	.00	.00	0.53	.00	9.52	5.26	.00	.00	13.04	1.00
B II b iii	2.04	.00	5.56	2.70	.00	.00	4.76	15.79	9.52	.00	4.35	17.33
B II b iv	2.04	.00	.00	.00	.00	.00	.00	.00	.00	16.67	6.52	.20
B II b v	4.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	26.09	11.55
B II b vi	.00	.00	8.33	8.11	1.60	4.35	.00	.00	.00	.00	.00	.00
B II b vii	.00	.00	.00	2.70	.00	.00	2.38	.00	.00	.00	.00	.40
B III a	.00	6.67	5.56	5.41	2.67	2.90	.00	.00	4.76	.00	.00	3.19
B III a ii	.00	.00	2.78	.00	.00	2.90	.00	.00	.00	.00	2.17	.40
B III b I	.00	.00	.00	.00	.00	.00	2.38	.00	.00	.00	2.17	.20
B III b ii	.00	.00	22.22	2.70	.00	1.45	4.76	.00	4.76	.00	4.35	.20
B IV a	4.08	.00	.00	2.70	.53	1.45	.00	.00	9.52	.00	.00	.80
B IV a ii	4.08	.00	.00	.00	2.14	13.04	.00	10.53	4.76	.00	.00	11.55
B IV a iii	2.04	.00	.00	8.11	.00	2.90	.00	.00	.00	.00	.00	.00
B IV a iv	8.16	.00	.00	.00	.00	2.90	.00	.00	.00	.00	.00	.60
B IV b I	.00	.00	.00	.00	3.21	.00	.00	.00	.00	.00	.00	.20
B IV b ii	.00	.00	.00	.00	1.07	.00	.00	10.53	.00	.00	2.17	.00
C	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
D	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
E	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Total (%)	100	100	100	100	100	100	100	100	100	100	100	100
Tot.count	*64*	*30*	*41*	*46*	*203*	*81*	*51*	*38*	*21*	*24*	*55*	*560*

Fig. 11. Relative frequencies (%) of designs in ceramic assemblages from limited activity stations.

still an important factor that affects the structure of each ceramic assemblage. Apparently, access to resource patches, whether inland or on islands, was affected not by territoriality or social boundaries but mainly by distance.

Summary of Results

1) There are obvious differences in ceramic design styles between residential sites. The variation within each assemblage is limited, consisting of a few dominant styles that do not overlap with dominant styles of other residential sites. Therefore, decoration can be used as an indicator of residential group identification.
2) Ceramic assemblages from residential sites have lower diversity (lower richness and lower evenness) than locations, which indicates there were certain limits of stylistic variation within a group. The higher diversity detected in assemblages from limited activity stations indicates sharing of resource patches.
3) Distances between residential sites and limited activity stations in large part account for the distribution of designs in shellmidden ceramic assemblages.

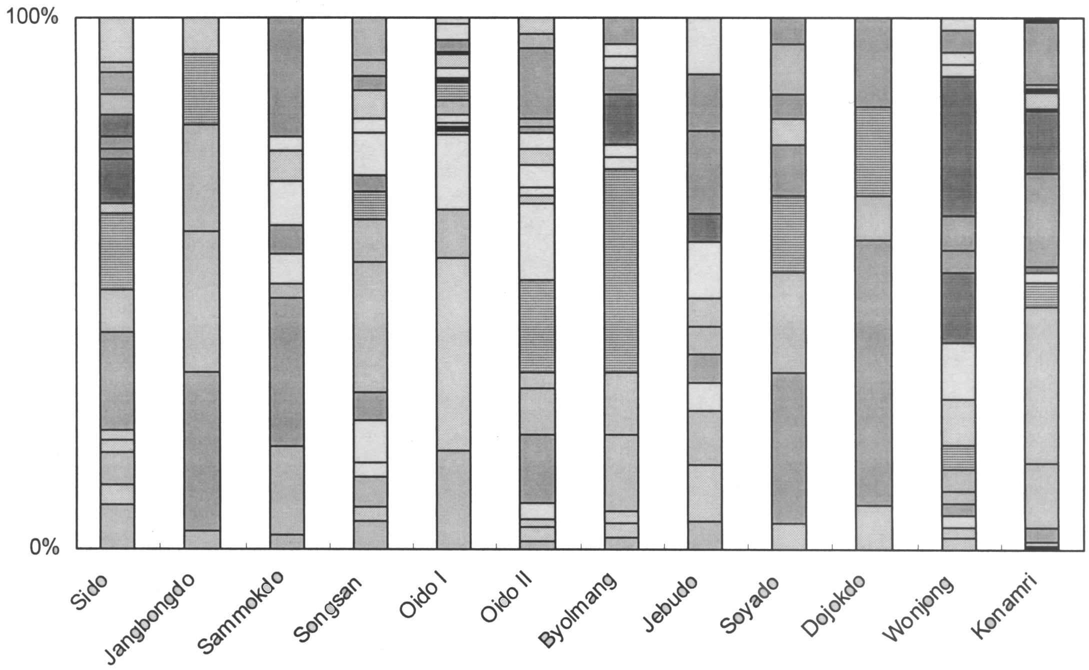


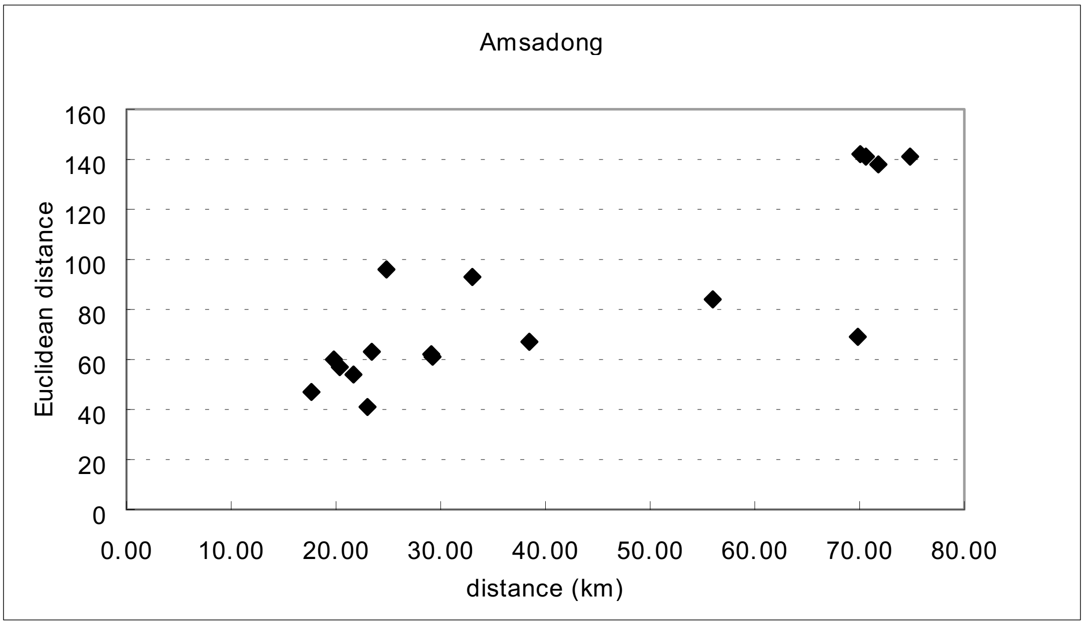
Fig. 12. Summary chart of relative frequencies (%) of designs in ceramic assemblages from limited activity stations (cf. Fig. 11).

Land Use Strategy of the Central-western Korean Late Chulmun

Results of analyses indicate that shellmiddens and non-shellmidden limited activity stations in the central-western Korean LC were resource patches exploited by various groups. Combined with the small islands' lack of necessities and inappropriate conditions for year round occupation, the obvious difference in ceramic assemblage between small island sites and residential sites demonstrates that small island sites were limited activity stations for multiple LC foraging groups.

Limited variability of ceramic styles at residential sites and the stylistic difference in the ceramic assemblage from each residential site indicates that each group made stylistically different ceramics and had different stylistic traditions, suggesting that it is possible to approximately infer the provenance of each style from small island sites. By contrast, the high stylistic diversity in the ceramic assemblages from the shellmiddens indicates that various groups visited and exploited small islands and various groups participated in the formation and accumulation of shellmiddens. This means that access rights to specific small islands was not exclusive by one group, but shared by various groups. It may not have been officially shared on the basis of an explicit intersocietal contract, but at least it can be said that exclusive ownership on resource patches did not exist.

It would have been difficult and costly for LC foraging groups practicing logistical organisation to claim exclusive rights to all of their resource patches. If a group tried to claim exclusive use rights to numerous resource patches, the group would have had to leave somebody there or frequently patrol to secure and maintain those use rights. This is expensive and risky from both economic and political perspectives; the cost of defence may be higher than the return (Kelly 1995). When resources are scarce and (consequently) territories are large and difficult to patrol, the cost of permitting or granting access of other groups will be lower than the cost of defence. Under these conditions, Cashdan (1983, 1993) argues, foragers ensure reciprocal access to resources by maintaining social links to the group or individual(s) holding the right to grant permission for use of those resources. The cost of maintaining exclusive rights of access to specific resource patches would have been very high for LC foragers, especially in the case of islands not only far from residential sites but also lacking basic resources for domestic habitation. More importantly, to maintain a broad spectrum subsistence economy, it must have been



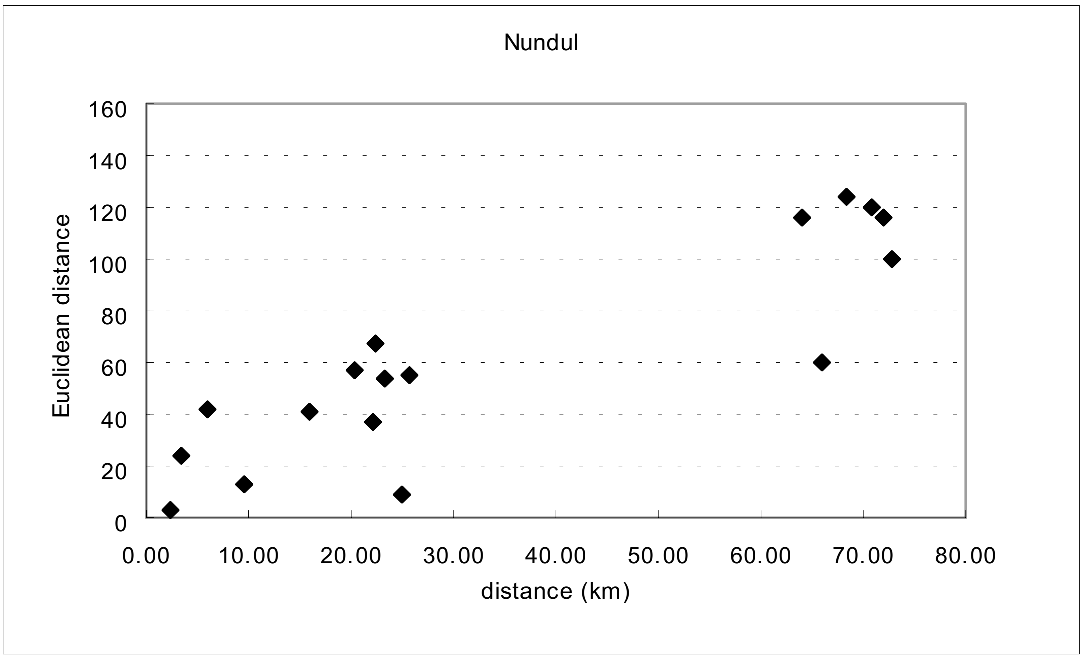


Fig. 13. Relationships between physical distance from specific residential sites to limited activity stations and Euclidean distance (Amsadong r = *0.83, Nundul* r = *0.88).*

necessary for LC hunter-gatherers to access various resource patches. Exclusive ownership of a limited number of patches, even if they were productive, would have decrease the number of patches available, creating difficulties in maintaining a broad spectrum economy. Therefore for LC hunter-gatherers, sharing resource patches was a stable and optimal economic strategy to maintain access to various patches.

This strategy may have been based to some degree on sharing rules and intersocietal negotiation among LC foraging groups, whether formalized or informal. Considering that the collection of oysters, the target resource for LC shellmidden exploitation, is concentrated during specific seasons (between autumn and early spring [Lee 2001]), there would have been many opportunities for a task group from a residential site to encounter other task groups from other residential sites. One might suppose that a group could still maintain some exclusivity by leaving some people at resource patches during the gathering season. However, although there is no direct evidence that can support or reject this possibility, some indirect evidence suggests that this was not the case. Staying on small islands where basic resources are extremely limited during the major gathering seasons of shellfish (i.e., late autumn to early spring) would have been very difficult. The fact that only open-air hearths with no substantial wintering structures are found on island sites strongly suggests that task groups did not stay long at limited activity stations during the oyster gathering seasons.

Likewise, there is no evidence for the existence of any maintained boundary. Rather, analyses show that it was distance, not a territorial boundary, that to a considerable degree determined the frequency of logistical visits to and intensity of exploitation at each shellmidden, though LC groups did still access islands farther than 80 kilometres from residential sites (see Fig. 13). However, this is not to say that LC foragers shared all patches. Long occupation durations at LC residential sites suggest a low degree of residential mobility and intensive exploitation of resources around residential sites. Therefore, it can be inferred that there was some territorial behaviour around residential sites. Although it is unknown whether this situation constituted a formal local territory, perhaps Binford's concept of annual range can be applied.

Sharing of Already-procured Resources versus Sharing of Access Rights to Resources

Resource sharing behaviour among hunter-gatherers (and farmers) has been one of the important issues in archaeology and currently two research directions can be discerned. One looks at resource redistribution among group members while the other focuses on exchange of resources between groups (see Jochim, this volume). The former tends to concentrate on how group members share resources with other group members and how this behaviour serves as a strategy for individual risk reduction and for group survival, often with the implication that such relations can lead eventually to the emergence of intrasocietal hierarchies (Gosden 1989; Hawkes 1992; Hegmon 1989, 1991; Kaplan and Hill 1985, 1992; Speth 1993; Winterhalder 1986). Intergroup redistribution analysis focuses on sharing of resources between groups, that is, exchange or trade, group level risk buffering strategies to address shortfalls, specialized production, debt relationships, and elite control of prestige (Gregg 1988, 1991; Halstead 1989; O'Shea 1981; Rautman 1993; Rowley-Conwy and Zvelebil 1989), often emphasizing how these behaviours play out in terms of regional adaptations and intersocietal inequality. Despite the difference in focus and scale of explanation, both approaches view sharing as not only an economic but also a social strategy (e.g., a gift relationship and/or social storage) and as having important evolutionary implications. Both regard sharing as a post resource acquisition behaviour occurring after resources are procured.

However, the preceding discussion of open access to resource patches in the LC leads us to the conclusion that sharing behaviour can take place not only after but also *before* resources are procured. This also means that the object of sharing is not limited to already-procured resources but can be extended to *rights to access to resources* before resources are procured. Open access to land and resource patches cannot simply be viewed as territoriality having been absent or property rights not developed. Rather, if based on some degree of intersocietal negotiation, resource patch sharing can be understood as another strategy in the realm of sharing whereby access to various resource patches can be effectively secured. As Smith (1988) and Kelly (1995) point out, land tenure and sharing are all forms of permission granting behaviours through which hunter-gatherers regulate access to resources. All such behaviours may be responsive to similar selective pressures; where exclusive ownership may lead to social conflict, open access to land is subject to selective pressures similar to other strategies of sharing. These different behaviours of sharing, however, operate in different forms at different scales. In a system of already-procured resource sharing, donors and recipients are clearly distinguished at the time of sharing. Donors expect that resources shared will be rewarded (socially and/or economically) later. Therefore, recipients are essentially borrowing property rights of resources from donors, and donors are temporarily giving up property rights for later use. In this light, many studies suggest that inter-group sharing behaviour is a risk-buffering strategy against possible seasonal/yearly shortfalls (i.e., social storage) on the one hand, and leads to debt-relationship, a long-term process toward intersocietal hierarchies, on the other. In this system, recipients are supposed to repay the cost of resources in the future, although sharing is based on an on-going reciprocity to some degree. The cost of already-procured resources can be described as the sum of the cost of resources and procurer's labour input (e.g., searching time, moving cost, processing time, and risk of acquisition). Also, recipients are supposed to pay additional social costs resulting from the debt relationship. Therefore, although this form of sharing can minimize economic risks because a group can expect direct aid from others, it is economically expensive and recipients must take the risk of entering into potentially unequal social relations.

In contrast, sharing of use-rights to exploitation of resources does not include sharing of labour costs of procurers because labour costs are not yet invested and each group inputs its own labour. Since the labour input, such as searching time, processing time, and risks involved in acquisition, constitute the major part of the cost of already-procured resources, sharing of use-rights is less expensive than that of already-procured resources, although "social storage" is also not involved. Each group takes on its own labour cost, but does not have to take a social risk. That is, while sharing of already-procured resources implicitly or explicitly leads to a debt-relationship between the donor and recipient, the sharing of use-rights does not. In addition, when the high costs of boundary maintenance and exclusive ownership of land are considered, resource patch sharing is a much less expensive strategy.

Therefore, if each group shares resources or use-rights with other groups for economic insurance, then from the *economic* perspective the sharing of already-procured resources is an economic risk minimizing strategy for the future, while use-right sharing is a debt minimizing and less expensive strategy. On the other hand, from a *sociopolitical* perspective, sharing of use-rights to resource patches is a social risk minimizing strategy because of the possible intergroup conflicts when a group owns exclusive access to the patches. Sharing of already-procured resources is a social-risk taking strategy. In some sense, exclusive ownership of productive, reliable resource patches can be understood economically as a risk-minimizing strategy for the future that secures direct, exclusive access to resources (Adler 1996; Smith 1988). However, as discussed above, it is at the same time a socially risky and economically expensive strategy.

It is difficult to determine from archaeological data whether the open access to resource patches characteristic of the LC was simply a lack of property rights to land or sharing of access rights to patches based on intergroup negotiation. However, it is suggested that at least some degree of implicit socially negotiated sharing or granting was practiced among LC foraging groups, because there would have been many opportunities for task groups from residential groups to encounter each other at resource patches, especially at shellmiddens which were visited primarily between late autumn and early spring.

It must have been economically costly and socially risky for LC groups to possess exclusive rights to specific resource patches, because this could provoke intersocietal conflict. Even if claiming exclusive rights to a productive resource patch brings a group more immediate economic advantages, the group claiming ownership may no longer be able to access other resource patches, which would, in turn, cause long-term economic problems. Therefore in the Central-western Korean case, the logistical organisation of resource exploitation can be understood as based on some degree of social negotiation involving sharing of resource patches with other foraging groups. Adopting this strategy means that each group had access to various resource patches for various target resources. This type of sharing lessens the cost and risk of social storage, while it also lessens the effect of social storage. By sharing access rights to resources, LC foragers would have been able to avoid conflict with other groups and access various patches according to their needs. They did not have to produce surplus for sharing or reward. Resource patch sharing cannot be simply seen as a lack of territoriality. Rather, it was a negotiated strategy.

Conclusion: Open Access to Resources as a Strategy

Access rights to resource patches were shared among forager groups of the Central-western Korean Late Chulmun period. For foragers relying on a broad spectrum economy and logistical mobility, it is critical to access a variety of resource patches. Although access to critical patches can be secured by claiming exclusive ownership, it is an economically expensive and socially risky strategy. Rather, access to multiple, varied patches can be better guaranteed by sharing access rights with other potentially competing groups.

Territoriality has been considered an important indicator of social complexity and thus it is often viewed as an important criterion for determining whether a group is labelled affluent foragers and/or complex hunter-gatherers (Koyama and Thomas 1981; Hayden 1994; Rowley-Conwy 1983). The development of territoriality is seen as having critical evolutionary implications (e.g., Earle 1991, 2000; Johnson and Earle 2000). Studies of territoriality amongst foragers are often based on the premise that affluent environments and concentrated productive resources act to promote high population densities, with territoriality as a logical and necessary consequence. Likewise, territoriality, despite its high cost, is viewed as an effective socioeconomic strategy to secure access to geographically concentrated critical resources.

In contrast, my examination of the situation suggests that territoriality may not be a natural consequence of environmental affluence or a universal indicator of socioeconomic complexity. Territoriality is simply one of many strategic choices made by hunter-gatherers. By the same token, lack of territoriality may not necessarily be a characteristic limited to foragers in poor environments or otherwise indicate a lack of socioeconomic complexity. Open access to resources, whether or not it is an intentional avoidance of territoriality, can also serve to secure stable access to resources. In particular, when competition over the same resources and patches is anticipated, hunter-gatherers may strategically avoid claiming exclusive ownership over the resources or land. Possible conflict stemming from claiming exclusive ownership may lead to difficulty in maintaining a broad spectrum economy that relies on stable access to various resource patches. In this sense, maintaining a system of open access to resources can be thought of as another type of sharing behaviour. Although open access to resources does not amount to direct, tangible social savings for shortfalls in the same way as sharing or exchange of already-procured resources, sharing access rights to resources is a less expensive and less risky strategy.

Acknowledgments

I thank Colin Grier and Junzo Uchiyama for valuable comments on earlier versions of this chapter. This work was supported by a Korea Research Foundation Grant (KRF-2002-037-A00023).

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Jangsuk Kim
Department of Anthropology
Chonnam National University
Gwangju 500–757,
Korea
E-mail: jangsuk@chonnam.ac.kr

9th ICAZ Conference, Durham 2002
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13. Beyond Affluent Foragers

Jangsuk Kim and Colin Grier

As editors of this collection of papers, we quickly realised that the diversity of hunter-gatherers is perhaps only equalled by the diversity of those archaeologists and ethnographers who study them. In assembling papers from anthropologists focused on extremely diverse areas of the world, who themselves hail from a broad spectrum of countries that speak a wide variety of languages and have distinct intellectual traditions, it became obvious that this volume would incorporate a variety of agendas, approaches, and perspectives.

This translates into a certain dynamic that does and will always exist between diversity and generalisation. This volume has been assembled in order to appreciate the common ground that does exist in the study of affluent foragers worldwide and model the broad array of factors that come into play in explaining the economic, social, and political development and organisation of "Affluent Foragers".

Of paramount importance to the project is whether the common ground we hold represents a small area relative to that covered by the diversity. Contemplating this issue does seem to be an important direction in which hunter-gatherer thinking is moving, judging by recent work (e.g., Ames 2004; Panter-Brick et al. 2001; Terrell et al. 2003). The original "Affluent Foragers" concept was built on the idea of generalisation as an overarching objective, not simply as a result of the processual program from which it emerged but in that it explicitly posited that a limited range of factors, typically environmental and exogenous, were sufficient to explain the organisation of affluent foragers worldwide.

The intent of this volume has been to de-emphasise and refocus this program. This is not to eschew generalisation or reject environmental factors as necessary components of useful explanatory models. Rather, it is to marshal studies that acknowledge, emphasise and apply the complexity of factors that have been increasingly recognised as critical to understanding the development of affluent foragers in their local contexts.

In the chapters presented we have not attempted to create, impose or otherwise produce any kind of consensus or grand synthesis among the authors. Yet some central themes clearly exist, and in this chapter we attempt to make these themes explicit, elaborate on their implications, and identify where generalisation is detrimental to our understanding of "Affluent Foragers". Crystallising and amplifying these issues will, in our view, allow us to move productively beyond the conceptualisations of Affluent Foragers that currently exist.

Issues in the Study of Affluent Foragers

What's in a Name?

Hunter-gatherers, ranging from *Homo erectus* to those of the American Northwest Coast, are extremely diverse in not only their social and political organisation but also their subsistence economy. Yet, for much of the time over which they have been studied, the category of "hunter-gatherer" has been treated as a monolithic category defined primarily by an absence of food production. As Terrell et al. (2003) argue, this coarse distinction between foragers and farmers regularly leads to essentialist understandings of the nature of hunter-gatherer societies. Over the last two decades works have appeared that place a limited range of hunter-gatherer societies into a separate category, typically either "complex hunter-gatherers" (Price and Brown 1985) or "Affluent Foragers" (Koyama and Thomas 1981), based on a variety of organisational variables such as complex logistical organisation, existence of marked socioeconomic inequality, high reliance on storage, and significant sedentism. The categories "Affluent Foragers" and "complex hunter-gatherers" have contributed greatly to realising the diversity inherent in hunter-gatherer subsistence strategies and appreciating the range of sociopolitical systems they encompass. Clearly not all hunter-gatherers "lived in small groups and moved around a lot". Emphasising this point has done much to overcome the narrow, essentialistic view of hunter-gatherers that resulted from the generalisation of observations among foragers in desert or arctic environments.

Appreciation of the diversity inherent in hunter-gatherer groups is a welcome and necessary development in the maturation of hunter-gatherer studies. We would suggest, however, that a renewed tendency to essentialism is now evident in the categorisation of hunter-gatherers themselves. In the past, foragers were considered to be the opposite of farmers. These days, affluent foragers are placed in opposition to simple hunter-gatherers, particularly those that existed in harsh environments, as Koyama and Uchiyama highlight in the introduction to this volume. Thus, in a strange twist of fate, "Affluent Foragers" and "complex hunter-gatherers" – terms that were designed to mitigate essentialism and foster an appreciation for the diversity of hunter-gatherers – have produced another typological debate within the previously (erroneous) homogenous category "hunter-gatherers".

Classificatory terminology and typological systematics in archaeology are just mechanisms for ordering observed variability in the record and not explanations for that variability. In this respect the categories we work with need not and should not be reified. In taxonomy, if our arbitrary classificatory groups become too rigid then we risk imposing structure on variability where none may have in fact have existed. Overemphasising typological distinctions also tends to reference the archetype rather than focus on critical variability. An appreciation of diversity may thus be more crucial than an appropriate typology, and in some respects our terminology may be hindering our efforts for explanation.

For example, most authors herein have felt it important to point out that the term "complexity" itself is in various respects problematic as a label, or at least must be explicitly qualified. One major issue that repeatedly arises is the implicit connotation that complexity equals "advanced" and "dynamic" while simple equals "static" and "unproblematic". These labels are anachronistic, and the terminology of complexity should be applied without implying such value judgments. Another important and perhaps unintended yet problematic outgrowth of this focus on applying the category "complex" is the emphasis that gets placed on demonstrating that the archaeological or ethnographic group one studies was indeed "complex" and thus worthy of study. This position, we believe, has produced a couple of further problems. On one hand, it tends to result in specific variables, such as sedentism, storage, and intensified exploitation of resources, being held up as "key" markers of complexity when it is in fact the interrelationship of a suite of variables that is typically required to explain organisational aspects of complexity. On the other hand, it is dismissive of the significance of studying "non-complex" hunter-gatherers except as a foil for complexity.

Much of the value-laden essentialism stems from the long-held perception that hunter-gatherer societies existed off the main path of social and political evolution. In recent years, complex hunter-gatherers have received a great deal of attention, and it is now (hopefully) widely recognised that the study of complex hunter-gatherers will provide some key insights into major changes that ensued in socio-political and economic organisation prior to the adoption of food production. As Ken Ames (2004, 364) has recently stated, "hunter-gatherer studies matter", meaning *all* hunter-gatherer studies. Yet, we are now in danger of including complex hunter-gatherers in the group of societies that "matter" while leaving "simple" foraging hunter-gatherers out of it. As the studies in this volume illustrate, we clearly need to focus on organisational variability in local contexts, not labels.

Many of the authors in this volume bring up the point that complexity is a relative issue. We could add "relatively" every time we write "complex". Yet it should be clear – and many scholars would readily agree – that complexity should always be understood with respect to three points of qualification. First, no human societies are in fact "simple" except in a relative sense. The social lives of individuals in even the smallest scale hunter-gatherer societies can involve very complex relations and their economic activities can involve an intricate array of scheduling, task differentiation, and mobility (e.g., papers by Nakajima and Plug, this volume). Second, it is clear that, at least on a gross scale, and when we view complexity in terms of the "sand pile" model discussed by Loponte et al. (this volume), that it is the formal political organisation of hunter-gatherers that is typically qualitatively simpler than those of more complex Chiefdom and State societies. Many hunter-gatherers negotiate their political relations through social relations. Political agendas and imperatives are thus not lacking amongst hunter-gatherers, they simply remain in a somewhat "grass roots" form. Third, few if any hunter-gatherer societies live without interacting with their neighbours, and thus socioeconomic complexity is not limited to or expressed solely at the intrasocietal level. Many authors in this volume argue that studies of hunter-gatherer complexity require consideration of intersocietal phenomena, including intergroup social storage, exchange, negotiation, competition, and conflict (papers by Grier, Ikeya, Jochim, and Kim, this volume). Clearly complexity is manifest at a variety of intersecting scales, as Grier points out in his chapter in this volume.

An important limitation in the definition of complexity may be that the last three decades of hunter-gatherer research has privileged a few novel characteristics abstracted from a limited number of observed (typically ethnographic) societies in order to explain the general emergence of social complexity. Loponte and his colleagues (this volume) effectively illustrate this limitation in the application of the concept of complexity, pointing out that certain archaeological indicators have been used primarily to determine whether or not a hunter-gatherer group was complex. Typically, if some potential indicators of complexity, such as sedentism, storage, territoriality and social inequality, are found, then the group is labelled as "complex hunter-gatherers". If such indicators are not seen, this group is labelled as "non-complex hunter-gatherers". Moreover, once a group was determined to have been a complex hunter-gatherer group, its characteristics were conventionally used to determine whether those in other regions developed the same level of complexity. Through this tendency, characteristics of complex hunter-gatherers in Jomon Japan and American Northwest have been overgeneralised. This situation underscores that we tend to treat variability in a very reductionist sense, which in fact has stifled if not outright prevented satisfying and flexible models for complexity.

The Evolutionary Implications of Complexity and Affluence

A critical point of clarification pointed out by Loponte et al. (this volume) is that the terms complexity and affluence refer to quite distinct organisational properties of a society. The term affluence, and more specifically "affluent foragers", emphasises material affluence as a condition or outgrowth of a productive natural environment. The term complex "hunter-gatherers" has tended to be invoked when addressing organisational complexity in economic and social systems. From an evolutionary perspective, the relationship between the two has not always been clear. Is an abundant environment (often interchangeably referred to as an "affluent" environment) a necessary pre-existing condition for complexity? If an environment in which hunter-gatherers subsist can be described as affluent, is complexity an inevitable result? Are there "simple" hunter-gatherers in affluent environments? Similarly, are there "simple" hunter-gatherers that have adopted some form of food production? Clearly small-scale hunter-gatherers have been drawn into the orbit of food production economies and state level political systems and as a result engaged in food production. But can small-scale foragers adopt food production without first becoming "complex"?

Perhaps the most critical dimension to these issues, and one that can be addressed empirically, is whether complexity is an inevitable trajectory or otherwise irreversible process when it occurred in affluent environments (Rowley-Conwy 2001). While complexity (however defined) may have broad evolutionary implications, in specific cases it appears to be but an organisational strategy adopted in a given situation, time, and region. As Kim (this volume) points out, for example, territoriality may have been strategically avoided and sharing of access rights may have been selected over territoriality in order to minimise social conflicts and increase stability of access to various resources. If territoriality is considered to be a critical component of complexity, does this make these societies less complex than those who adopt territoriality? Uchiyama (this volume) argues that characteristics of Jomon hunter-gatherer societies considered to be typical of complex hunter-gatherers, particularly their sedentary and aggregated settlement patterns and high population densities, were adopted when useful rather than as part of a unidirectional process of evolutionary change. In the Jomon situation it is prudent to view these features not as progressive developments but as a part of an overall situational strategy adopted for a relatively short period of time in response to human impacts on the environment, as Uchiyama argues.

How then can complex hunter-gatherers have evolutionary implications? How can complex hunter-gatherers be an evolutionary stage that links "simple" hunter-gatherers and agriculturalists? A significant and important issue that arises from such questions, and one quite different from the terminological and classificatory problems mentioned earlier, is whether "simple" hunter-gatherers (that is, highly mobile groups typically employing primarily a residential mobility strategy and avoiding storage) are qualitatively or quantitatively different from the more complexly organised (economically at least) hunter-gatherers. Here, we might expect less agreement among scholars and indeed different perspectives do exist even between the authors of this chapter. Grier (this volume) asserts that different types of questions must be asked depending on whether we deal with foragers or complex hunter-gatherers while Kim (this volume) argues that some traits of complex hunter-gatherers are simply strategically avoided by many "simple" hunter-gatherer groups. Are all hunter-gatherer studies describing variation of the same phenomenon? Answering this question ultimately requires addressing whether complexity is a process that has a critical threshold and whether the development of complexity represents a qualitative shift or quantitative increase in organisational dynamics.

The questions raised above likely do not have simple or easy answers. It is clear that current castings of complexity offer only partial answers, and the explanations they provide may be not the only ones worth seeking. We sit at a starting point rather than a concluding stage given the state of current models.

Causality

Causality as a research topic has loomed large in hunter-gatherer studies. This stems from attempts to account for hunter-gatherer change in the broadest respect, but also in that the trajectory of change has been viewed as one headed towards food production. While change is neither unidirectional nor irreversible (Rowley-Conwy 2001), clearly causality is a required and central feature of explanatory models. A broad array of factors have been discussed and advanced in the past and in this volume to account for trajectories of change in hunter-gatherer societies. Here, we consider just a few of the main factors in order to evaluate how well they have worked in explaining hunter-gatherer organisation, what role they can most appropriately play in explanatory models, and the inter-relationships between these factors.

Environment

No other factor has so dominated hunter-gatherer research as "the environment". The intimate relationship between hunter-gatherers and the ecological structure of the environment makes environmental variability an alluring explanation for cultural variability (e.g., Binford 2001). The affluent forager concept was developed under this premise, and both explicitly and implicitly advances the notion that the socioeconomic complexity of certain hunter-gatherer groups is related directly to environmental abundance. Under this premise it not difficult to make the leap from positing environmental variability as a generator of socioeconomic variability to the view that environmental change generates cultural change. Indeed, the list of case studies that privilege not only environmental change specifically but external change more generally as a prime mover in hunter-gatherer change is long. However, so are the criticisms of its use as primary causal factor.

First and foremost among the criticisms is that this view of hunter-gatherers casts them as societies that exist in stasis unless exogenous pressures promote responses. On one hand, such an approach robs human beings of any active role in constructing their own society, and, on the other, implies that hunter-gatherers are always in harmony with their environment. It is clear from a number of case studies in this volume that environmental stability does not prevent cultural change, nor does environmental change automatically demand an organisational response on the part of hunter-gatherer groups. In some cases, long trajectories of change occur amidst environmental stability and in others environmental change seems to evoke no obvious socioeconomic shifts (Gassiot and Estevez, this volume). There is clearly no deterministic argument to be made either theoretically or empirically. This is not to say that there is no real world out there to which societies must respond by adjusting their organisational strategies. There is and always has been the pragmatics of day-to-day and year-to-year existence that no one can deny or ignore.

However, on the whole, the ecological structure of the environment seems best suited to play a role as but one constraint among many that influence the behavioural choices of foragers. Organisational strategies are clearly a response to a social environment as much as a natural one, as Kim (this volume) points out in his study of the costs and benefits of various forms of territoriality. Yet, even in this situation it is important to consider the ecological structure – how controllable resources may in fact be, whether they are predictable enough to be worth defending with a strategy of territoriality, and so on. But what drives Kim's study, and what is required in attacking such problems, is significant thought directed toward how much of a constraint environmental circumstances play in specific local contexts.

The de-emphasis of ecological imperatives and focus on the social environment has interesting implications for whether the organisational strategies of certain complex hunter-gatherers makes them "pre-adapted for" or "pre-disposed to" adopt food production. We suspect the particular socioeconomic organisation of small-scale or incipient agricultural societies would not have been entirely novel or unfathomable for hunter-gatherers such as those that existed on the prehistoric Northwest Coast of North America or in Jomon Japan. As Nakajima (this volume) suggests, some Jomon economic practices may have made the adoption and practice of agriculture of the Yayoi period a relatively easy transition. Perhaps the risks and costs of adopting a novel economic strategy (food production versus food collection) may have been offset by the afforded continuity in social practices. Similar social structures can exist under markedly different economic regimes, and this may be most true in relation to the adoption of agriculture by certain complex hunter-gatherers (Lee, this volume).

As a whole, we believe the environment (broadly construed) and change therein presents solely a constraint that must be accommodated to various degrees depending on the specifics of local circumstances. Such changes can be accommodated in many ways within a repertoire of possible organisational responses. We feel that specific case studies in this volume make that point effectively.

Technology

What role does technology play in the equation? Technology clearly has a central and limiting role in complex foraging systems (Builth, this volume). For example, no hunter-gatherers could harness the energy of fossils fuels and so that energy in not available to fuel their economic systems. But beyond such obvious limits, what causal role (if any) does technological change play in fostering change in hunter-gatherer societies?

Unfortunately, most incorporations of technology into the equation are either overly functionalist or possiblist, suggesting that if a need arises for a technological advance, it occurs. This tends to underestimate the latent technological capabilities of prehistoric societies. Major technological revolutions, such as metallurgy, are indeed great leaps forward. But the adoption of expensive technologies is to assume high cost and risk, and thus tends to be delayed until either potential adopters are sure about higher future benefits (economic or social) or there are urgent socioeconomic needs to do so (Kim 2001, 2003). Yet, conversely, such technological developments as "storage" may represent intensifications or slight modifications of existing behaviours, many of which have likely existed as long as there have been anatomically modern humans.

On the Northwest Coast of North America, for example, it has long been debated when storage of salmon or flatfish began (e.g., Cannon 1996; Croes and Hackenberger 1988; Matson 1992). One assumption has been that when storage was first intensively used is tantamount to when the process of storage itself was initially conceived or "invented". Similarly, net fishing, and specifically the technology of the reef net, has been suggested to lie behind a major economic revolution in the salmon storage economy (Coupland 1996). Yet, the reef net can be seen as a more complex and coordinated application of basic fish netting procedure. What is more likely novel were the socioeconomics of its implementation as a technology and the new relations of production orchestrated and promoted by those who most successfully applied the technology to existing situations. Technological innovation as a eureka-style event may be a fairly rare occurrence and thus not particularly useful as a causal explanation for change. In fact, technological change may be primarily an outgrowth of other changes, and as such marked periods in which significant change was occurring in other spheres (Kim 2001, 2003). Moreover, demonstrating that a technology did not exist prior to its appearance in the archaeological record is different than saying it was not in use due to minimal social or economic incentives to do so - a common view in discussions of the adoption of agriculture. Technological innovation may then fall into the same realm as "history" in that it is what needs to be explained rather than being an explanation itself.

Decoupling Complexity from Inequality

George Cowgill (1996, 20) has described the transition to inequality as a switch in the predominant polarity of resource transfers, which change primarily from the transfer of resources from "haves to have nots" to "have nots to haves". As simple and general as this statement is, it suggests that the structures of resource transfers are fundamentally a social issue and that the development of inequality need not be accompanied by a "complexification" of social or economic relations.

Inequality is therefore not tantamount to complexity in any meaningful definition of either, as inequality represents a particular form of structural relations – economic, social, and political. This is clearly a different issue than complexity itself. Relations of inequality need not be more complex quantitatively or qualitatively than egalitarian relations. Are there more resource exchanges, reciprocal obligations, or positions of authority in a society that has unequal transfers of resources? We suspect not (as a general rule). But inequality and complexity do correlate in some ways, though that need not mean that there is any deterministic relationship. Complexity of resource transfers tends to separate products from producers, often in the form of managed stores and control of certain means of production by a limited set of individuals. The separation of product and producer creates opportunity for other individuals to affect the flow of resources. Intensification creates certain types of surpluses, both momentary and net yearly, as well as opportunities for those surpluses to be controlled and their distribution manipulated by individuals concerned with power. Surpluses can be used to accomplish political manoeuvres that require financing beyond what an individual's productive capacity might allow.

In this sense it is clear that inequality requires some kind of affluence in that there must be resources available to control, and thus we see a potential theoretical correlation between affluent foragers and inequality. Affluence, construed as the production of economic surpluses, may perhaps be a necessary precondition for institutionalised economic inequality to develop among hunter-gatherers. However, that realisation does not in and of itself mean that affluence causes inequality, or that inequality equals complexity. Many researchers have parsed aspects of this equation previously, including Randall McGuire (1983), who made an effective argument that inequality and complexity should be seen as different and distinct organisational parameters. Studies in this volume, particularly Gassiot and Estevez and Loponte et al., demonstrate that these variables also appear independent when measured in the archaeological record. In the cases studies they present it is clear that societies deemed complex under almost any archaeological definition do not and need not display obvious relations of inequality.

Beyond Affluent Foragers

Hunter-Gatherer Evolution

As we said at the outset, identifying causality and formulating explanations for hunter-gatherer change go hand in hand with modelling hunter-gatherer evolution. Recent neoevolutionary theory has emphasised this point, yet much recent neoevolutionary literature has narrowed the problem domain to the study of selectionism and cultural transmission (e.g., Lyman and O'Brien 2001; O'Brien and Lyman 2002, 2003). Others outside of the neoevolutionism paradigm have argued for a focus on cultural transmission and at the same time promoted a shift away from neoevolutionary theory in the strict sense (e.g., Shennan 1993).

Both selectionism and cultural transmission are important elements of charting evolutionary trajectories amongst hunter-gatherers. Yet we would argue that a central component of the equation – the production of cultural variation – has been sidelined and/or dismissed as not relevant or even feasible to study. In our view, a focus on the generation of cultural variation involves investigation of the ways in which culture is produced or generated by social actors prior to being subsequently selected for or against, and ultimately transmitted down the line. How humans themselves actively produce new culture is absolutely critical to model, as it is often intentional (unlike genetic variation) and determines behaviours available for selection.

The generation of cultural variability, a process describable in evolutionary vernacular, represents a sphere of inquiry that takes us well out of the range of the sorts of problems that neoevolutionary theory has typically tackled and in which hunter-gatherer research has been trapped for much of its past. In evolutionary theory, biological variation is essentially random, as it stems from unpredictable genetic mutations. However, the production of cultural variation in human societies is anything but random. It is the product of social actors working to create and manipulate circumstances and relations, with the objective of shaping culture according to the vision they have for it and the role they wish to play in it. Such a notion allows us interject concepts such as "knowing actors", "agendas", and "rational and irrational propensities" (Cowgill 1993), and otherwise problematise the realm of social and political relations in hunter-gatherers, which have been typically thought of as unproblematic and epiphenomenal.

Cast in this light, environmental change must be viewed as but one potential agent of change in any society, acting primarily as a constraining factor in the agendas of real people making real decisions in their lives. Certainly the environment may operate at certain times to place "selection pressure" (at times very acute pressure) on the viability of cultural strategies. Moreover, it may shape the options or limit the range of cultural production engaged in by social actors in developing strategies for organising themselves and others in their local context. But as numerous studies in this volume indicate, there are extended periods of time in which the environment appears to have exerted very limited selection pressure in terms of the promotion and transmission of cultural strategies.

Humans create culture, and work actively to create their own culture and a world in which they would prefer to live. Individual and group strategies and relations of power are critically involved in this process. This element of the situation is as much a part of understanding evolving systems as the processes of cultural selection and transmission. To ignore this may simplify the problems we confront, but our goals need not be reductionist in archaeology. We can accommodate the study of complexity in all its complexity.

Beyond Hunter-Gatherer Ecology

Part of the initial problem with the heavy handedness of environmental causality has come from a lack of appreciation for the distinction between ecology and economy. This distinction has been well articulated by Halperin (1989) but yet seems to have been overlooked in hunter-gatherer research perhaps due to its Marxist roots, which have often been eschewed in hunter-gatherer studies (e.g., Bettinger 1991, 145–9).

The basic notion distinguishing ecology and economy is that, as Karl Polanyi (1957) originally argued, an economy is inherently a social process. All organisms that are capable of movement move around the landscape to acquire resources. How this occurs can be modelled with respect to ecological theory. However, Halperin (1989) has argued that we should not mistake the spatial movements of hunter-gatherers and resources in a particular environmental situation as an economy. Termites may forage, but they do not have "an economy" in any sense we would wish to apply that term. In human societies, the fundamental difference is that resources move to those who need them through exchanges that are governed by social relations. It is ultimately social relations that facilitate the movement of resources to consumers.

This is a useful lens with which to view the recurrent application of Binfordian collecting and foraging models. It all too often appears as though the characterisation of hunter-gatherers as either collectors or foragers passes for a description of a "hunter-gatherer economy". A critical point to recognise is that the Binfordian model is simply a description of the spatial ecology of hunter-gatherers – how hunter-gatherers organise themselves spatially on a landscape to acquire resources in a particular environmental structure (what Halperin [1989] calls "locational" movements). The assignment of a group to a particular point or range in a collector-forager continuum describes or implies nothing about the way in which social relations (the organisation of labour, sharing networks) operated to acquire, distribute, and consume resources (Halperin's [1989] "appropriational" movements).

Halperin argues that it is the integration of both appropriational and locational movements that constitutes an economy. Hunter-gatherer studies have privileged the locational, ecological problems at the expense of the appropriational, social problems, with perhaps the notable exception of sharing as a research issue. In this volume, we suggest a reversal of that trend is warranted, both theoretically and empirically. We reject methodological assertions that this inherently social problem domain is somehow too archaeologically invisible or too difficult to study, or any theoretical position that states such appropriational relations are simply too epiphenomenal, capricious, or irrelevant to warrant our attention.

An important aspect of moving beyond the limited focus on hunter-gatherer ecology is to recognise how the two aspects of economies, locational and appropriational movements, can articulate. It appears that in some respects these two aspects of an economy can vary independently. Using a modern example, one could envision two factories in disparate areas of the world having very similar mechanisms of organising the material production process of making running shoes. They might make use of very similar strategies of acquiring the materials, have similar sewing equipment, and so on. But if one pair of shoes is made by an 11 year old child in a country lacking child labour laws while the other is made by union labour in the western world, an entirely different set of socioeconomics exists in the two workplaces and the individuals involved in the production process relate in fundamentally different ways to the society and its power structure.

However, elements of spatial ecology and social economy may have specific and predictable links. For example, Woodburn (1982) and Hayden (1995) have drawn direct links between spatio-temporal systematics and social organisation, suggesting that delayed return systems, which involve separation of production and consumption in time and/or space (an ecological issue) typically involve high degrees of storage and socioeconomic inequality. In seeking an evolutionary explanation for this link, we might envision a situation in which managerial roles developed and applied in the production process may, at least initially, be extended to the control of surplus products. The existence of such a link does not imply storage will produce inequality. Stores can be managed without unequal relations of access to those stores existing.

Yet, stores of surplus foods may, in certain cases, become controlled by specific individuals under certain circumstances and subsequently used as resources for the construction of social inequality. The importance of storage in a particular ecological setting might itself become the justification for the control of stores by specific individuals who can effectively "manage" the situation. On the Northwest Coast of North America, the limiting factor in household production was labour (Ames 1996), and thus large households were interested in attracting members. The hosting of impressive feasts may have served that function. Prominent individuals within the household may have been allowed to consume surplus household resources (e.g., give as gifts to invited guests) in the process of feasting and other mechanisms for demonstrating the desirability and benefits of house membership to outsiders. In the process, their own personal status could have been enhanced as well, which could have acted to solidify relations of unequal access to resources for broader endeavours than those initially intended (i.e., pursuit of individual status enhancement or securing long-distances interpersonal alliances).

This scenario bridges an old managerial versus functional debate in the study of the emergence of leadership (Ames 1995) and places knowing actors at the centre of the generation and application of new set of appropriational relations to an existing ecological organisational systematic. New social relations created by social agents in light of specific agendas can be quite variable within a specific ecological structure. Many forms of appropriational relations may work in a given situation, even morally detrimental forms such as inequality (Grier 2000). Also, social organisational forms (e.g., labour groupings) generated for specific subsistence endeavours may be applied to new spheres of subsistence, as when complex hunter-gatherers adopt food production.

In some cases, there may be serious contradictions between the ecological and economic realities, as discussed by Gassiot and Estevez (this volume). New forms of culture may be subject to various forms selection pressure, be they environmental (e.g., inability of an ecological setting to sustain increased production demands) or social (e.g., levelling mechanisms), yet the diversity that remained possible in past hunter-gatherer organisational strategies is underscored by the great range of hunter-gatherer socioeconomic variability.

In light of these points, we therefore need to work towards two things. First, we must obtain an understanding of the subtle ways in which the environment does and does not constrain behaviour, and whether those constraints actually explain the social and political phenomena that are of interest. Distinctions between cause, pre-existing and necessary conditions, and consequence must be clear. Second, we must look to the strategies that are used in affluent environments – how variable are they? The issue we have to confront is that the rise of complex hunter-gatherers represents the rise of new and decidedly un-forager-like social organisations within a framework of predictable spatial-temporal mechanics for acquiring resources. Stated another way, we can measure the differences in forager-collector ecological systematics, yet that does not explain the variation in social systems that hunter-gatherers exhibit. Moreover, there can in fact have been quite variable socioeconomics within a single spatio-temporal pattern (e.g., collectors exhibit vast differences in inequality). This clearly requires thinking beyond collectors and foragers. We have always been amazed at the simplicity of the Binfordian model, yet on the other hand what it in fact explains is quite limited.

Looking Forward

Our objective in this volume has been to present theoretical ideas and empirical studies that broaden the problem domain represented by "Affluent Forgers" and "complex-hunter gatherers". We are encouraged by the great deal of interesting thinking evident in these areas of research, both in this volume and within the discipline in general. Yet we also feel it is important to explicitly emphasise research trajectories that we feel will provide the most satisfying answers to recurring and often thorny issues in hunter-gatherer research. We agree wholeheartedly with Ken Ames that hunter-gatherer studies matter. In order to amplify their relevance, we suggest that:

(1) Typological debates and distinctions in which the objectives are solely to order variability among hunter-gatherers have contributed little to explaining the development of hunter-gatherers. Data organisation does not equal problem resolution.

(2) Discussions of Affluent Foragers and/or complex hunter-gatherers tend to overgeneralise the characteristics of a few societies and apply these characteristics as expectations for all hunter-gatherers (e.g., the Northwest Coast of North America or Jomon Japan). This tendency in turn leads to narrow and essentialistic views of complex hunter-gatherers that hinder our appreciation of diversity and search for explanations for that variability.

(3) Existing models have limited explanatory power as long as they present hunter-gatherer behaviour as a group-level reaction to environment; we need to consider various levels of behaviours (e.g., individual level, household level, regional level).

(4) Simplistic ecological understandings of hunter-gatherers (as was the case with the original "Affluent Forager" model) are insufficient to explain hunter-gatherer variability and evolution. We need a broader perspective that includes consideration of social phenomenon such as exchange systems, competition and negotiation, territoriality, and, ultimately, individual agendas and motivations as the generators of cultural variability.

(5) Models must consider strategic choices of hunter-gatherers under given circumstances rather than presuming that the degree of environmental affluence determines hunter-gatherer socioeconomic organisation. Hunter-gatherers are not hyper-rational but rather socially-contingent actors, and thus strategic choices are fundamentally socially-embedded and derived from specific agendas.

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Jangsuk Kim
Department of Anthropology
Chonnam National University
Gwangju 500–757
Korea
E-mail: jangsuk@chonnam.ac.kr

Colin Grier
Department of Anthropology and Sociology,
University of British Columbia
6303 NW Marine Drive,
Vancouver,
BC Canada
V6T 1Z1
E-mail: grier@telus.net